POWER

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The Old Standby

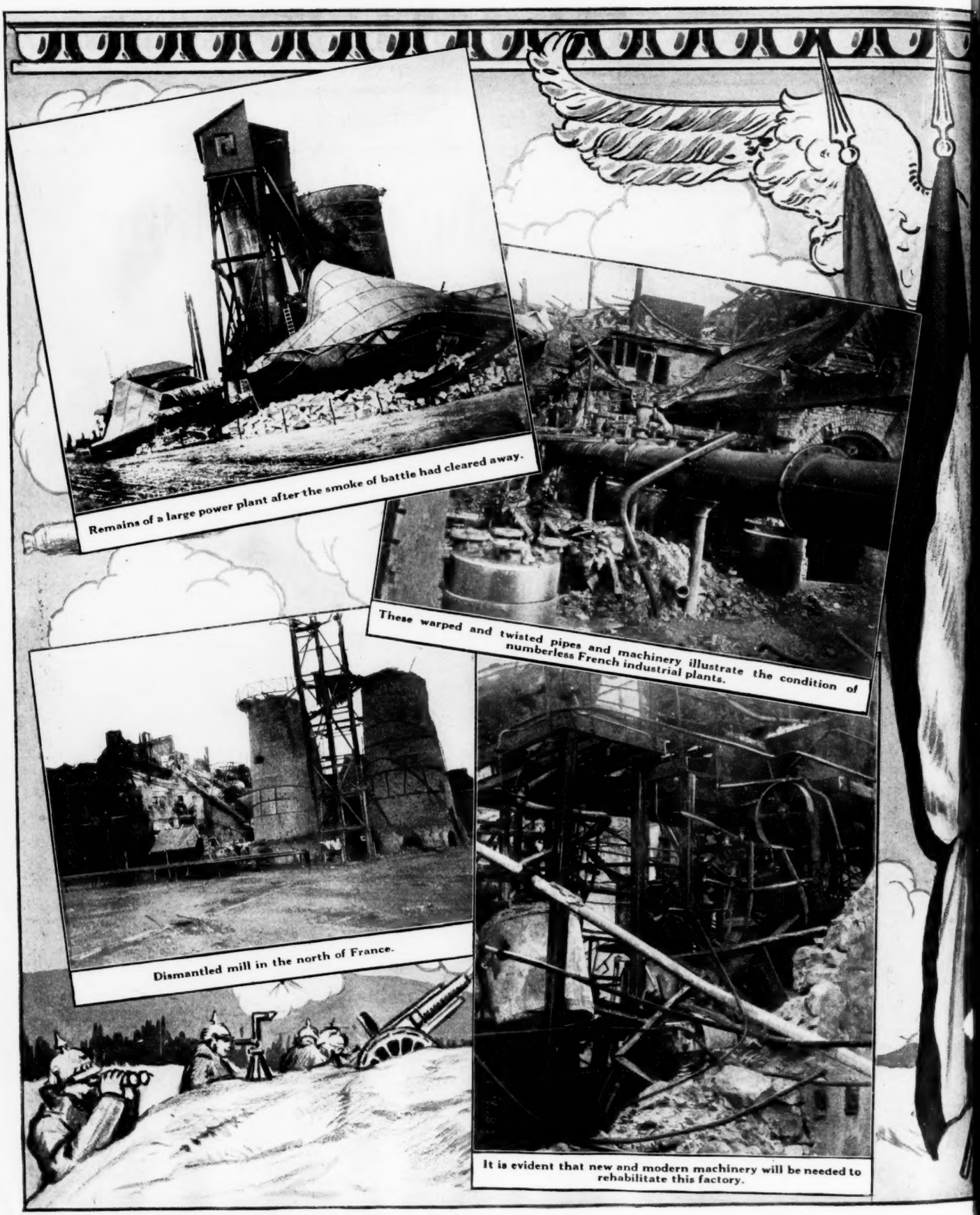
By Berton Braley

THE transmission line is a thing to admire
As over the country it's stringing,
And the big central station's a sight to inspire
The poets to music and singing.
But my little lyric is one that concerns
A job of much smaller displacement,
But one that—quite frequently—brings the returns,
The little old plant in the basement!

It isn't impressive, it won't give you thrills,
It's frequently dinky and dingy,
But when you check up on your assets and bills
The saving it shows isn't stingy.
There's many a central plant patron who's sad
Because he forgot what the space meant,
Which once held the faithful old friend that he had,
That little old plant in the basement!

It stands by itself and it works for itself,
And it doesn't quite suddenly flivver
Because there's a storm on a bleak mountain shelf
Or a washout somewhere on a river.
It 'tends to its business for year upon year,
Of shutdowns shows scarcely a tracement,
Unless you're in wrong with your own engineer
Of the little old plant in the basement!

So here's to the plain little subcellar plant,
Which still in affection we nourish,
Though people may say that its chances are scant
And only the big stations flourish.
They're simply mistaken, they're lacking in brains
To fill up their cranial casement;
It's not disappearing—it stanchly remains,
That little old plant in the basement!



Remains of a large power plant after the smoke of battle had cleared away.

These warped and twisted pipes and machinery illustrate the condition of numberless French industrial plants.

Dismantled mill in the north of France.

It is evident that new and modern machinery will be needed to rehabilitate this factory.

What War Does to Industry

Reproductions of illustrations from the report of the American Industrial

A great deal of machinery will be needed to re-equip this destroyed textile factory.
Three hundred and thirty factories and mills have been destroyed, throwing out of work approximately 57,633 people and depriving families of workers of support.
Another startling example of the necessity for new industrial equipment.
Big problem in France will be to get the wheels of industry humming again. There are thousands of plants to be rebuilt and equipped with modern machinery.

Ruined Power Plants and Factories

Commission to France, 1916. Reviewed on Page 235 of "Power" for Feb. 13, 1917

Power Supply and Development in Japan and Chosen

By Ludwig W. Schmidt

SYNOPSIS—A general discussion on the electrical-power industry in Japan, pointing out what has been accomplished and what the possibilities for the future are in this line of activity in Japanese Far East.

At the beginning of the European War Japan had 15,881 factories, 9403 of which were operated by electric motors. Industrial progress for a period following the Russo-Japanese war had been very rapid, and the supply of the Japanese industries with power presented an ever-increasing problem. The situation was further complicated by the fact that the use of electrical energy as motive power for industrial purposes had suffered a severe check in consequence of the financial failure of one of the leaders in that industry in Japan; consequently, for a while it was difficult to interest capital in much-needed electrical expansion.

A government investigation seemed to show that none of the then existing enterprises paid more than over 1 per cent. profit. Also it was generally accepted that only concerns possessing large capital would be able to operate successfully. The consequence of this was that not only was private capital unobtainable for some time, but also the development of small industrial power stations came to a standstill.

Increase in Number of Power Plants

The pressing demand for power supply finally overcame the fear of the investor, and this, with the increasing prosperity of the country, soon justified the optimism of the promoters of electrical enterprises. While there were in 1903 only 85 electrical enterprises, in 1912 the number had grown to 310 and in 1913 to 385. The capital invested in these undertakings in 1903 was approximately $9,000,000, increasing to $178,730,890 in 1912 and to $236,061,225 in 1913. The number of electric lights increased from 36,500 in 1903 to over 6,000,000 in 1913, while the motors in use increased from 563 to 28,000 and the horsepower from 4000 to over 110,000 for the same period.

The full significance of these figures is best understood when compared with the general power generation and supply situation in Japan. Most of the factories driven by electric motors are of medium size. But the rapid industrial development in a time when the rest of the world had already reached a very high industrial standard made it possible for Japan to build a number of big engineering and other industrial enterprises. In these the motor and machine equipment is of the most modern kind. Japanese engineers were constructing with the experience of the industrial world at their disposal. This explains also the large employment of motive power. From 1912 to 1913 no less than 692 new factories were built, nearly all of which are using electric motor drives. This perhaps shows best the present-day tendency of industrial development in Japan. During 1913 7048 (6900) steam engines were used in Japanese factories, developing 514,699 (471,805) hp. The figures in parentheses represent in this case and in the following the situation during 1912. Gas engines in use numbered 1451 (1251) supplying 41,400 (31,971) hp. The number of petrol motors had decreased to 912 (1100), giving 6605 (7395) hp. Water turbines, on the other hand, showed an increase both in number and in power. Their number was 217 (177) developing 180,405 (105,688) hp. There was also an increase in dynamos of the large type. There were in use 1284 (1194) machines producing 362,033 (263,991) hp.

War Influenced Electrical-Power Industry

The war has influenced the electrical-power industry in several ways. The first effect was a general industrial depression all over Japan. The Japanese industries were without orders and without means to ship. They had no raw materials, and the manufacturers were unable to buy in consequence of the rising prices. This continued until the beginning of 1915, when a sudden change took place and the Eastern markets began to buy from America large quantities of goods that formerly were supplied by Europe. The small Japanese industries began to operate again, however; the increasing foreign demands soon created a situation that they were unable to meet without increasing their producing facilities. The electrical-power stations were the first to feel the change. The power demand increased rapidly, an increase which became even more marked when the Japanese iron industries began to fill the large war orders from Russia.

The electrical-power industry was well prepared for the rush. During the early part of 1914, when war was still not thought of, a number of new power stations had been opened and several new companies had begun operating. When, during the summer of 1915, the industrial boom came, there were over 550 power stations ready to fill the demand for electrical current. These stations had a capital of approximately $300,000,000 at their disposal, with an available power production of 746,145 kw.

It is interesting to note that nearly 0.8 of this power was produced by transforming water power into electrical energy and only 142,160 kw. produced by steam generation. Also, with regard to this development, in comparison with the former years there has been a decrease in the steam generation and an increase in hydro-electric power.

Hydro-Electric Development Possibilities

Japan offers many possibilities for hydro-electric development. The island is mountainous with, in some cases, very rapidly descending slopes to the sea. There is sufficient water power obtainable to feed the Japanese industry for a considerable time to come. The Japanese government so far has shown great ability in the handling of the national power supply, both hydro-electric and other, and only recently has issued a number of orders facilitating the application of electrical power throughout the country. This regulation had for its aim especially the standardization of the supply and its distribution. Japan has learned that occasional droughts may in-

terfere seriously with a regular supply of power. If a high degree of standardization both of the generating and of the distributing equipment can be obtained, it will be possible to combat effectively any derangement of the service in one direction by coupling one station to another.

Before the war Japan obtained the better class of her power machinery almost exclusively from England, Germany and the United States. It is an interesting fact that the whole business was practically divided among a very few of the leading English, German and American manufacturers. Imports of electrical machinery have been fairly large since the beginning of the present century. According to Japanese figures Japan imported since 1900 approximately $20,000,000 worth of electrical machinery. In 1900 the imports were only $488,000; however, they rose very quickly and have averaged since 1911 $2,000,000 per annum.

The export figures of Germany, England and the United States as recorded by the export statistics of these countries are not always borne out by the respective import values as recorded by Japanese statistics. However, a close study of these exports is worth the time, as it gives a fairly correct view of the needs of the Japanese market with regard to the type and price of the power machines in demand.

German Machinery Exports to Japan

Germany, for instance, exported in 1913 to Japan steam boilers to the value of $21,250. During 1913 also, 26 steam engines at a total price of $132,500 went to Japan. This would make an average price of approximately $5000 for each engine. Gas engines, which for some time were largely in demand in Japan from German sources, practically ceased to be exported. On the other hand, there has been a rapidly increasing demand for water-power machinery. In 1911 $195,250, in 1912 $166,250 and in 1913 $429,250 worth of water-power machines were ordered in Germany by Japan. Orders for internal-combustion engines decreased from $240,750 in 1911 to $118,000 in 1913.

The situation in the dynamo business between Germany and Japan as it presented itself during the period of 1911 to 1913 is of considerable interest. The value of this business was $1,127,250 in 1911, $878,750 in 1912, and $805,000 in 1913. During 1911 there were supplied 5600 electric motors representing a value of $756,238. All these prices are the export prices and do not include the expenses for shipping and the profits of the importer.

It is unfortunately not possible to compare the foregoing prices with those asked by American exporters of the same goods, as the American export statistics do not give the information in question. The general opinion in eastern Asia, however, is that German dynamos and motors are the cheapest in the market, excepting, of course, the Japanese. It is also not possible to compare exactly the size of the German business done in Japan with that of the American business. German export records end with the year 1913, and American records specifying dynamos and electrical motors only begin with this period.

United States exported to Japan during 1913 dynamos and motors to the value of $1,248,000 and during 1914 to the value of $1,698,069. During the latter year the export value of gas engines amounted to $9408, stationary gasoline engines $15,653 and stationary steam engines $13,450. In each case there has been a considerable increase over the export figures for the years 1913 and 1912.

The first year of the war had a depressing influence on the sales of American power machinery in Japan. Only $300,830 worth of dynamos and $303,360 worth of electric motors were shipped to Japan in the year 1915. The English export figures with regard to Japan are not very complete. They show that England exported to Japan electric motors in 1912 to the value $1,213,000; in 1913, $939,000; and in 1914, $890,680.

Power Machinery Demand Will Increase

There is no doubt that the demand for electrical machinery will increase again with the return of peace. The electrical-power industry, after having got over its earlier difficulties, has become a very strong factor in the economic life of Japan, and the chances are that its influence will become still stronger with the growth of general industrial activity. The first and essential condition for the continuation of this growth is the proof that investments in electrical enterprise in Japan will pay. This is evident from a list of 22 Japanese electrical enterprises having a paid-up capital of $92,028,469, which paid an average dividend in 1913 of 6.8 per cent. One of the companies paid 13 per cent. and three others 12 per cent. dividend; two of them showed a loss, and two others, although showing a net earning of $3,785,137, did not pay a dividend. The total paid-up capital of all electric railways in 1913 was $115,530,775, the expenditure $7,599,747 and the net earning $7,818,481.

Generally speaking, the Japanese government does not encourage the investment of foreign capital in industrial enterprises vital to the economic life of the nation. Nevertheless, Germany and England have assisted in former years in the building up of the Japanese power industry either by giving substantial credits or by taking over shares when necessary. How the situation will be after the war it is difficult to say; before the war it was customary to give long-term credits. A new company would pay an installment on its machinery with the order, another payment was made when the machines arrived and possibly a third when the machines were installed. The remaining part had to be left standing for some time until the enterprise began to pay. Japanese buyers will hardly change this system, and American manufacturers already have complied with the situation by allowing approximately the same credit as their competitors. An extension of American power-machinery exports will have to take into consideration the general industrial situation in Japan. Not all industries have shown the same progressiveness in using electric motors.

Japan Manufacturing Electrical Machinery

The war, by making it more difficult for Japan to purchase power machinery in foreign markets, especially Europe, has encouraged Japanese manufacturers to build some of these machines at home. Several orders for big dynamos of as high as 6000-kw. capacity and more have been placed with Japanese manufacturers, and it appears that the experiment has been carried through successfully. It is not at all unlikely that this development may influence future business with Japan. It is, however, a question whether the Japanese concerns will be able to se-

cure sufficient business to make the building of these machines profitable. It cannot be to the interest of the Japanese power industry to increase unnecessarily the price for the power machines, and it seems that these machines can be built cheaply only when they can be sold to a world's market.

In closing, a few words may be said about Chosen (Corea). The total sum invested in the power industry of Chosen before the war was approximately $6,500,000. Electrical energy was used for lighting purposes as well as for the supply of power to industrial and mining enterprises. The machines in use are, as in Japan, mostly of English, American or German make. In 1913 electrical motors to the value of $4528 only were exported from United States to Chosen; in 1914 the value increased to $11,561 and decreased under the influence of the war to $1015 in 1915. Also the export of dynamos was limited, having in 1913 a value of $9113, in 1914 $20,143 and in 1915 only $3680.

The electrical development of Chosen under Japanese management has really only begun. The Japanese government has made an exhaustive study of the hydroelectric possibilities of its possession, and it is certain that after the war more rapid progress will be made.

A closer coöperation between Japanese and American capital has been suggested by leading Japanese statesmen. This proposal is worth investigating, since the Japanese are the most active economic unit in eastern Asia.

Draft in Steam Boiler Practice

By J. D. Morgan

SYNOPSIS—The theory of draft and a comparison of the first cost of procuring it by various means is discussed at length, together with the operating cost and the effect of draft on the rate of combustion.

Few engineers realize the importance of draft in the operation of boilers, so the matter has in the majority of cases been left to the designing engineer. The most common method of creating a draft is by means of a chimney or stack. Just what draft a stack of a certain height will produce is not generally known, because of the number of calculations involved. Charts Figs. 1 and 2 show the theoretical drafts obtained from chimneys of various sizes. Fig. 3 shows the relative cost of brick chimneys and mechanical draft and Fig. 4 the capacities of chimneys of various sizes. The hotter the chimney gases and the higher the chimney the greater the draft, therefore some gain is obtained from hot chimney gases, but this is slight in comparison to the loss and is far from being an economical way of producing an increased draft. A brick stack is more efficient than an unlined steel stack, owing to the radiation of heat from the latter; but if the steel stack is brick-lined, there is little difference except in first cost.

Following are the various well-known formulas for chimney calculations, all reduced to common units from which almost any problem in design of chimneys can be computed.

Adams

$$Height = \left(\frac{F}{14A}\right)^2 \qquad Area = \frac{F}{14\sqrt{H}}$$

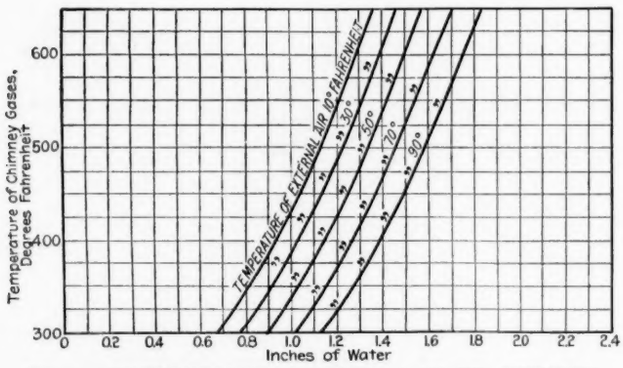


FIG. 1. THEORETICAL DRAFT OF A 200-FT. CHIMNEY

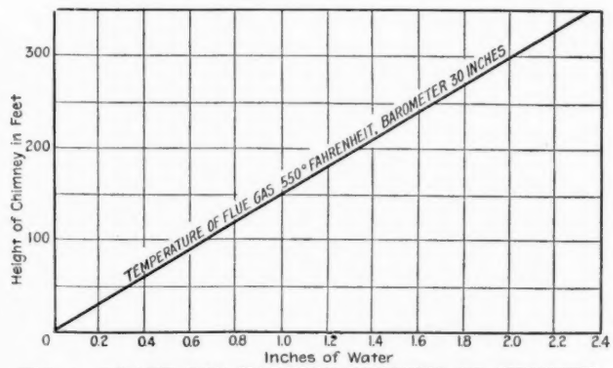


FIG. 2. DRAFT FOR VARYING HEIGHTS OF CHIMNEY

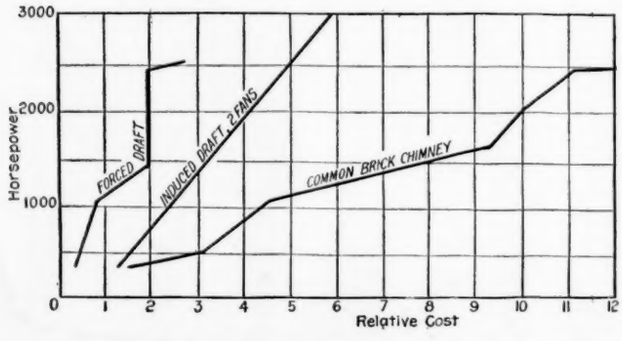


FIG. 3. COMPARISON OF COST OF DRAFT

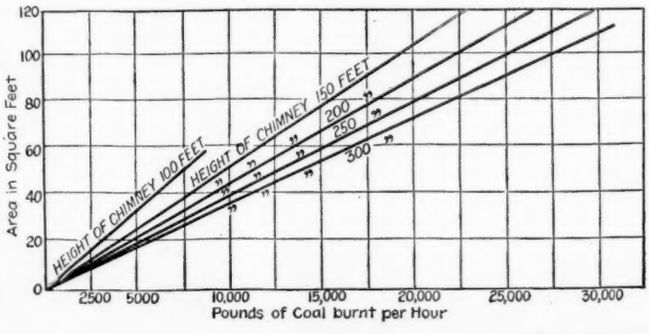


FIG. 4. SIZE AND CAPACITY OF CHIMNEYS

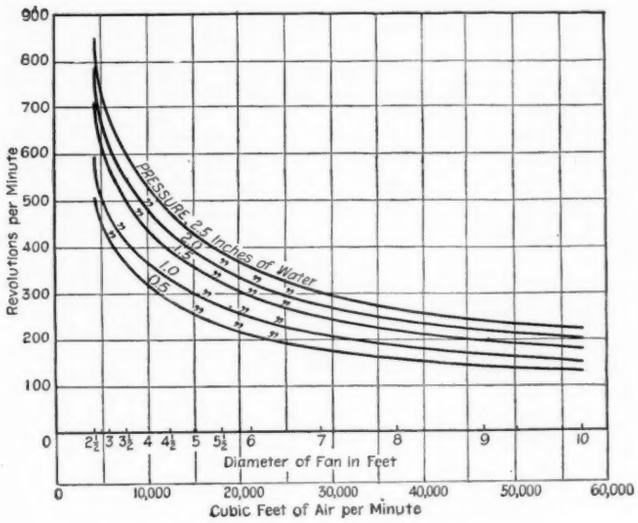


FIG. 5. SPEED, PRESSURE AND CAPACITY OF FANS

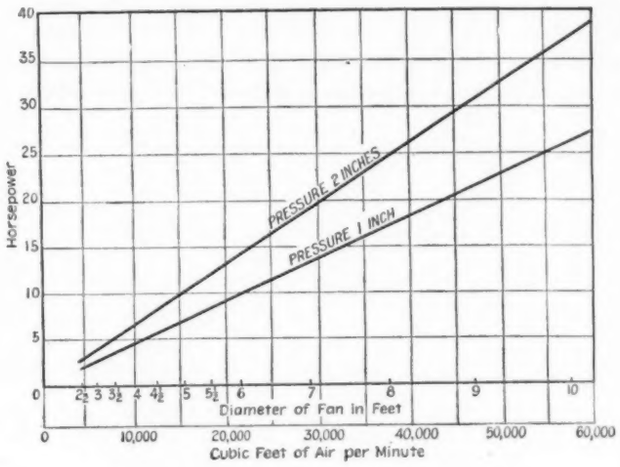


FIG. 6. HORSEPOWER REQUIRED TO DRIVE FANS OF GIVEN SIZES AND CAPACITIES

Christie

$$Hp. = 3.24A\sqrt{H} \qquad Height = \left(\frac{F}{KA}\right)^2 \qquad Area = \frac{F}{K\sqrt{H}}$$

Gale

$$Height = \frac{180}{t}\left(\frac{F}{G}\right)^2 \qquad Area = 0.07F^{\frac{1}{2}}$$

Ingenieurs Taschenbuch

$$Height = 0.216\left(\frac{F}{G}\right)^2 + 6D$$

Kent

$$Hp. = 3.33E\sqrt{H} \qquad Height = \frac{0.3Hp.^2}{F2} \qquad Area\ or\ E = \frac{0.3Hp.}{\sqrt{H}}$$

Lange

$$Height = 15D + 32.5 \qquad Area = 0.00049\,BF$$

Molesworth

$$Hp. = 1.28A\sqrt{H} \qquad Height = \left(\frac{F}{12A}\right)^2 \qquad Area = \frac{F}{12\sqrt{H}}$$

Nagel

$$Hp. = 2D^2\sqrt{H} \qquad Height = \frac{Hp.^2}{4D^4} \qquad D = \left(\frac{Hp.}{2\sqrt{H}}\right)^{\frac{1}{4}}$$

Nystrum

$$Hp. = 1.45A\sqrt{H} \qquad Height = \left(\frac{F}{12A}\right)^2 \qquad Area = \frac{Hp.}{1.45\sqrt{H}}$$

Rankine

$$Height = \frac{13\,\frac{V}{2G}\left(\frac{W}{n\delta}\right)^2\left(\frac{T_1}{T_0}\right)^2}{0.96\,\frac{T_1}{T_2} - 1 - \frac{0.06D}{2\delta A}\left(V^2\frac{WT_1}{n\delta T_0}\right)^2}$$

Smith

$$Height = \left(\frac{F}{12A}\right)^2 \qquad Area = \frac{0.0825F}{\sqrt{H}}$$

Sterling

$$Height = \frac{d_1}{0.8M} \qquad D_1 = C(Hp.)^{0.4}$$

in which the following notation is used:

A = Inside area in square feet;
B = Weight of air per pound of coal;
C = 4.68 unlined stack or 4.92 lined stack;
D = Inside diameter at top in feet;
D_1 = Diameter in inches.
d_1 = Net available draft, inches of water;
E = Effective area $= A - 0.6\sqrt{A}$;
F = Pounds of coal burned per hour;
G = Grate surface, square feet;
$Hp.$ = B.hp.;
H = Height above grate in feet;
K = $\frac{7}{1.89G}$ bituminous coal or $\frac{F}{G}$ anthracite;
M = Theoretical draft per foot of chimney height;
n = Ratio of grate to chimney area;
$T_0 = A61$;
T_1 = Temperature of flue gas, deg. F. abs.;
T_2 = Temperature of external air, deg. F. abs.;
t = Temperature of flue gas, deg. F.;
V = Cubic feet of air per pound of coal 32 deg. F.;
W = Pound of fuel burned per sec.;
δ = Weight of cubic foot of chimney gas 32 deg. F.;

There is no essential difference in the use of forced and induced draft. Figs. 5, 6, 7, 8, 9 and 10 are a series of curves showing the capacity of forced-draft fans and also performance curves for blowers. The original cost of fans is small—about 50c. per b.hp.—and there is but little difference in cost between them for forced or induced draft, but under forced draft another method must be considered; namely, the steam blower. This system has its own particular field, its drawback being the amount of steam used. Chart 11 shows the approximate steam consumption of a natural- and a forced-draft stoker installation.

Increase in draft in relation to increased rating for any particular boiler can be obtained only by tests, but the stronger the air current through the fire the greater the rate of combustion, and the stronger the current of gases the faster heat is absorbed by the heating surface. A fuel bed that is thicker than is best for the draft available is often carried.

Draft loss is the most important consideration and is in all probability the least understood, as it is a complicated subject on account of the number of items entering in, some of which are fuel bed, boiler design (that is, height and spacing of tubes), length of gas travel, soot and ashes and baffles. These items are all variables, but follow the fundamental laws, which are as follows:

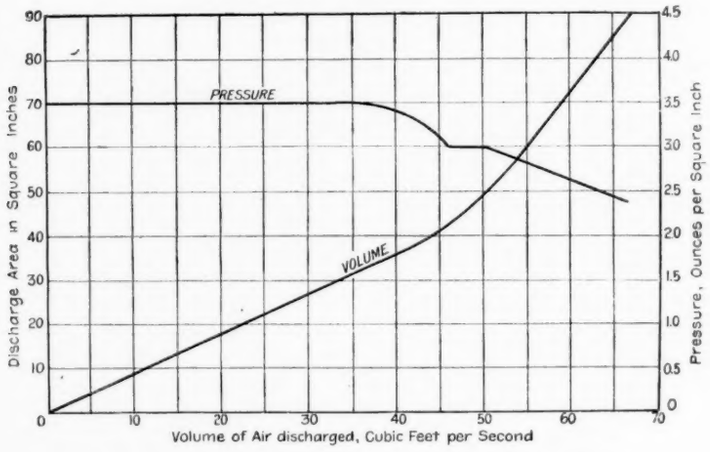

PRESSURE
VOLUME
Discharge Area in Square Inches
Pressure, Ounces per Square Inch
Volume of Air discharged, Cubic Feet per Second

FIG. 7. EFFECT OF VARYING DISCHARGE OPENING

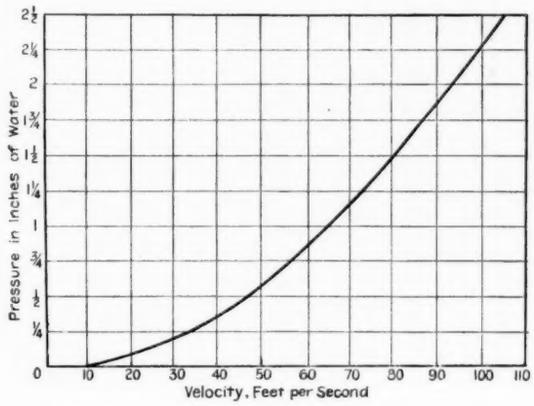


FIG. 8. VELOCITY OF AIR AT 50 DEG. F.

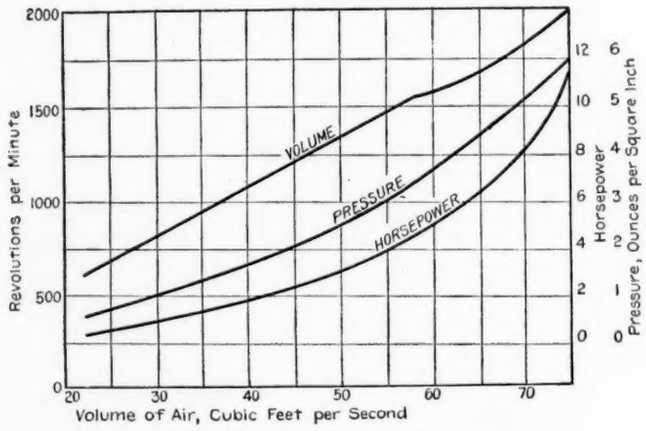


FIG. 9. EFFECT OF FAN SPEED VARIATION

If the resistance to the flow of gases remains a constant, the pressure drop through any part of the boiler will bear a constant relation or ratio to the total drop from the ashpit to uptake; conversely, if the total drop between the ashpit and the uptake remains a constant, the pressure drop through any part of the boiler will vary as the resistance to the flow of gases.

If the resistance through any part of the boiler remains a constant, the amount of gas passing through this point will vary in some definite relation to the pressure drop.

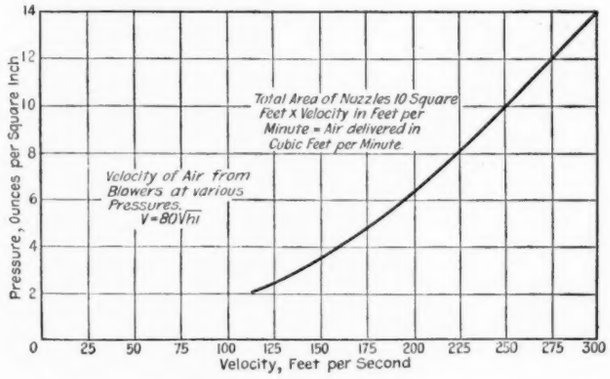

Total Area of Nozzles 10 Square Feet x Velocity in Feet per Minute = Air delivered in Cubic Feet per Minute
Velocity of Air from Blowers at various Pressures.
V = 80√H
Pressure, Ounces per Square Inch
Velocity, Feet per Second

FIG. 10. VELOCITY OF AIR AT VARIOUS PRESSURES

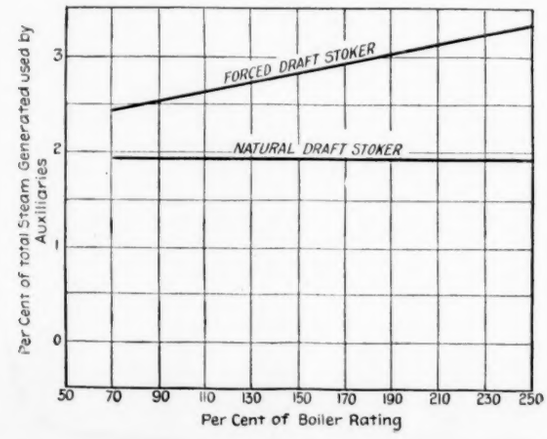

FORCED DRAFT STOKER
NATURAL DRAFT STOKER
Per Cent of total Steam Generated used by Auxiliaries
Per Cent of Boiler Rating

FIG. 11. STEAM USED BY STOKER AUXILIARIES

Following are given the results of a test on two 600-hp. B. & W. water-tube boilers fired with underfeed stokers. These tests were made in a very thorough manner, and

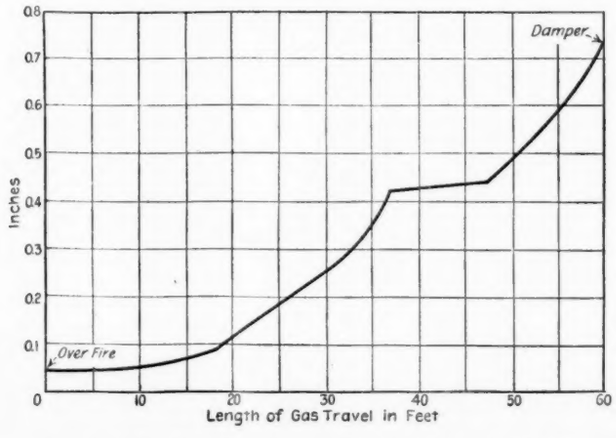


FIG. 12. DRAFT IN 600-HP. WATER-TUBE BOILER

hundreds of readings were taken to establish the average given. The results are plotted in Fig. 12.

	1	3
Boiler number		
Average steam pressure, lb	203	200
Average b.hp	728	947
Pressure in ashpit, in	2.730	2.650
Draft inside damper, in	0.745	0.815
Draft over fire, in	0.048	0.119
Drop from fire to soot chamber, in	0.697	0.696
Draft at 2nd row of tubes 1st pass, in	0.065	0.119
Draft at middle of first pass, in	0.075	0.156
Draft at top of first pass, in	0.092	0.171
Draft at top of second pass, in	0.265	0.342
Draft at middle of second pass, in	0.313	0.414
Draft at bottom of second pass, in	0.423	0.511
Draft at bottom of third pass, in	0.440	0.531
Draft at middle of third pass, in	0.509	0.592
Draft at top of third pass, in	0.565	0.638
Per cent. drop from fire to bottom of first pass	2.44	
Per cent. drop from bottom to middle of first pass	1.43	5.32
Per cent. drop from middle to top of first pass	2.44	2.15
Per cent. drop from fire to top of first pass	6.36	7.47
Per cent. drop from first to second pass	24.80	24.60
Per cent. drop from top of second pass to middle	6.88	10.35
Per cent. drop from middle of second pass to bottom	15.80	13.93
Per cent. drop from fire to bottom of second pass	53.70	56.35
Per cent. drop from second pass to third pass	2.44	2.87
Per cent. drop from bottom of third pass to middle	9.90	8.76
Per cent. drop from middle of third pass to top	8.04	6.61
Per cent. drop from fire to top of third pass	74.20	74.60
Per cent. drop from top of third pass to damper	25.80	25.40
Per cent. drop from bottom of first pass to top second pass	28.70	32.10
Per cent. drop from top of second pass to bottom of third pass	25.10	27.20
Per cent. drop from bottom of third pass to top of third pass	17.95	15.40

The drop through the fuel bed or the resistance of a fuel bed depends a great deal on the size of the coal, the method of firing, the nature of the ash and the grate construction, and each item must be obtained by actual

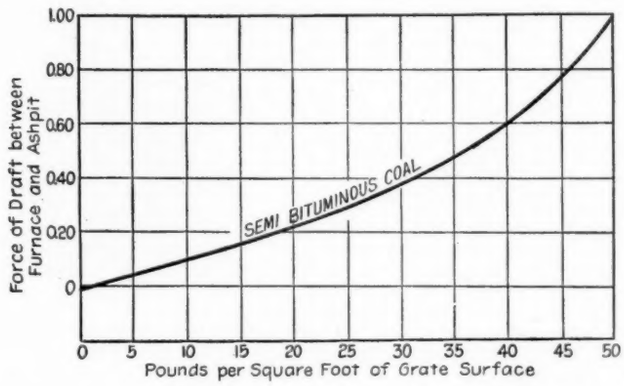


FIG. 13. INFLUENCE OF DRAFT ON COMBUSTION RATE

test and experiment. From a few incomplete tests it has been determined that the flow of air through the fuel bed does not diminish in the same proportion as the depth of the fuel bed increases, and in the matter of air supply that the amount of air required to burn one pound of combustible becomes greater as the differences in pressure.

Chart Fig. 13 shows the influence of draft on the combustion rate of bituminous coal.

"Helping Henry" Auxiliary Drive

Sometimes an automobile may save the day when an auxiliary power is wanted, by using a device termed a "Helping Henry." Suppose that power is down in the small steam plant, that the engine is undergoing repairs and no power is to be had, or that power to run the motor is off at the street service. It is a simple matter to back an automobile to the machine-shop window, or, if possible, run it in onto the floor, and after applying the device to the automobile and belting it to the machine to be used, start the engine and go ahead with the job (see Fig. 1).

"Helping Henry" consists of a steel frame upon which are mounted a couple of jacks (Fig. 2), which are placed under the rear axle housing. When the jacks are brought against the housing, the rear wheels of the automobile are lifted from the ground, and the tire treads are brought against two wide-rim pulleys mounted on a shaft, to

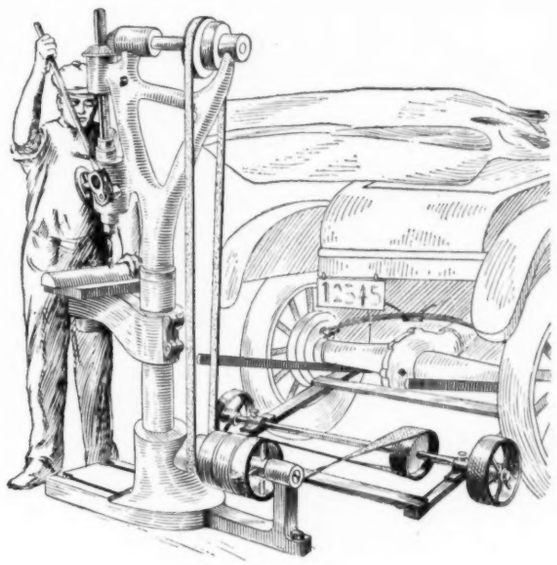


FIG. 1. THE "HELPING HENRY" AT WORK

which is also secured a belt pulley, from which a belt is run to the machine to be driven.

Upon starting the automobile engine with the driving mechanism in gear, power is transmitted through friction from the tires to the pulleys on the shaft, re-

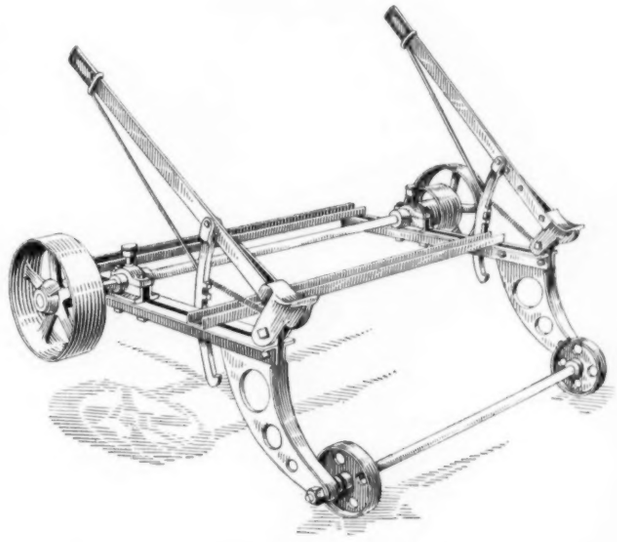


FIG. 2. "HELPING HENRY" IN DETAIL

volving them and thus driving the drill press, lathe or other machine.

This device is made by the Auto Power Co., Laporte, Ind.

Engine Pistons Suspected of Leaking Steam can be tested by placing the engine on the crank-end dead-center, and after removing the cylinder head on the head end, admit steam back of the piston. Any leak can be readily detected. Another method is to place the engine on either center and open the indicator cock from the opposite end from which the steam is being admitted. In this test, however, the steam valves must be tight.

Reconnecting Induction Motors—Diagrams of Semi-Closed Slot Windings

By A. M. Dudley

SYNOPSIS—Some of the typical forms of winding employed by all manufacturers in connecting induction motors are considered; their advantages, disadvantages and some of the possible changes that may be made in these windings to meet various conditions are pointed out.

In discussing possible changes in existing windings, frequent reference is made to the usual forms of connection. For this reason much space in this and the following articles is devoted to illustrations of the typical forms of diagrams that are employed by all manufacturers in connecting induction motors. A passing consideration will indicate that there would have to be an indefinitely large number of these diagrams to cover all possible combinations. For example, machines are usually connected either two-phase or three-phase. The three-phase machines may be either γ (gamma) or Δ (delta), any winding may be in series or two groups in parallel, a six-pole machine may be three parallels or six parallels or a ten-pole machine may be five parallels or ten parallels, etc. With these fundamental elements alone, if speeds from two poles to fourteen poles are considered, there are 81 diagrams of connections required. Then follows the fact that any one of these 81 diagrams may be used on a core having an indefinite number of different slots such as 24, 36, 60, 72, 90, etc., so it becomes evident that it would require a book of considerable proportions to include even the usual combinations encountered in ordinary commercial machines. Fortunately a simple system has been developed, and will be explained later, by which the number of slots can be eliminated from consideration in the group connections, since it affects only the number of coils that are connected together to form a pole-phase group and does not affect the connection of the ends of this pole-phase group to neighboring groups.

In the second article of this series, windings were divided, in general, into two classes with reference to whether they were used in partly closed slots or in open slots. The partly closed slot windings were again divided into four classes: (1) Bar and involute-end connector, (2) pushed-through, (3) hand-wound and (4) fed-in, or dropped-in.

So far as the polar connections are concerned, the bar and involute-end-connector windings may be handled in the same manner as a formed-diamond-coil winding used in open slots, since the bar may be considered as the straight portion of the coil and the involute connector as its diamond-shaped end. This would mean that these windings could be connected up into pole-phase groups and these groups in turn cross-connected according to any of the standard group connections in common use, of which a number will be shown in the fourth and succeeding articles of this series.

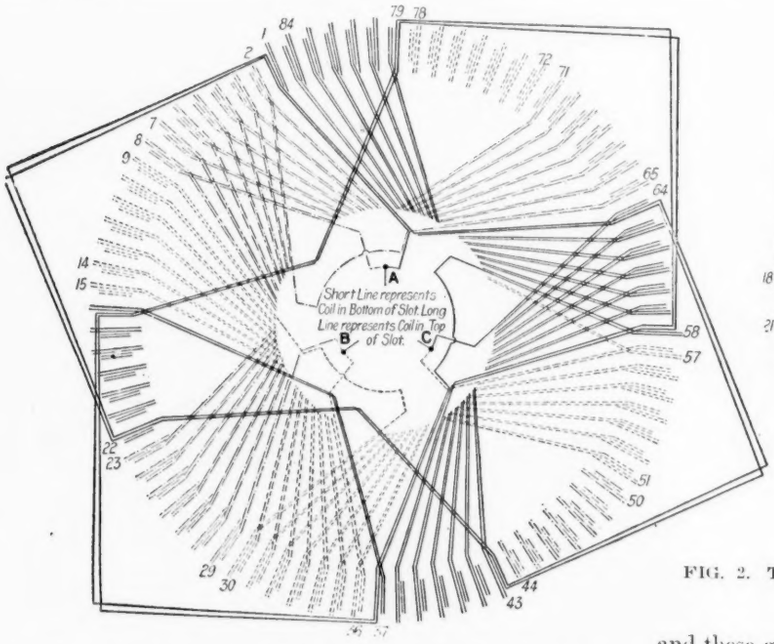


FIG. 1. THREE-PHASE, FOUR-POLE, SERIES-DELTA-CONNECTED WAVE WINDING

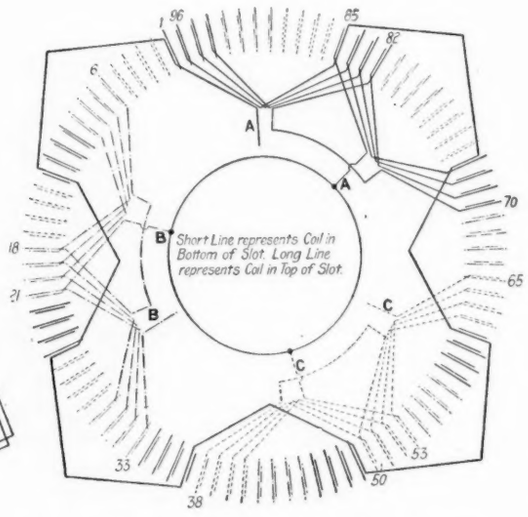


FIG. 2. THREE-PHASE, EIGHT-POLE, SERIES-STAR-CONNECTED WAVE WINDING

In addition to such connections, this type of winding has been often used as a wave or series-circuit winding such as is commonly employed in direct-current armatures. Windings of this type are illustrated in Figs. 1 and 2. It will be seen at once that a desirable feature of such a winding is its simplicity and compactness and comparative freedom from group-cross connections. These connections are limited to the connections for the star or the corners of the delta, the leads, and one series connection in the middle of each phase. When compared with the mass of connections for the simplest form of pole-phase group winding, the advantage is apparent. It will be noticed that the windings shown in Figs. 1

and 2 are perfectly symmetrical and balanced at all points, the number of slots being an exact multiple of the number of phases times the number of poles; this is true in practically all cases for this type of winding.

An interesting variation from the foregoing type is illustrated in Fig. 3 and is typical of a method of connection that has been widely employed, particularly on the rotors of motors of the phase-wound type. Here it will be seen that the number of slots, 62, is not an even multiple of 18 (3×6, phases times poles), but follows the same law as a direct-current, series or wave, armature winding; namely, the number of slots ± 1 divided by the number of pairs of poles must equal an integer, and this integer divided by 2 is equal to the proper pitch, or throw, of the connector. In the case shown in Fig. 3, $\frac{\text{number of slots} \pm 1}{\text{pairs of poles}} = \frac{62 \pm 1}{3} = 21$. The proper pitch of the coil is $21 \div 2 = 10.5$ slots; that is, the throw should be 10.5. Since this is not physically possible, the throw is made 10 slots or 1 to 11 on one end, and 11 slots or 1 to 12 on the other end, giving an average of 10.5.

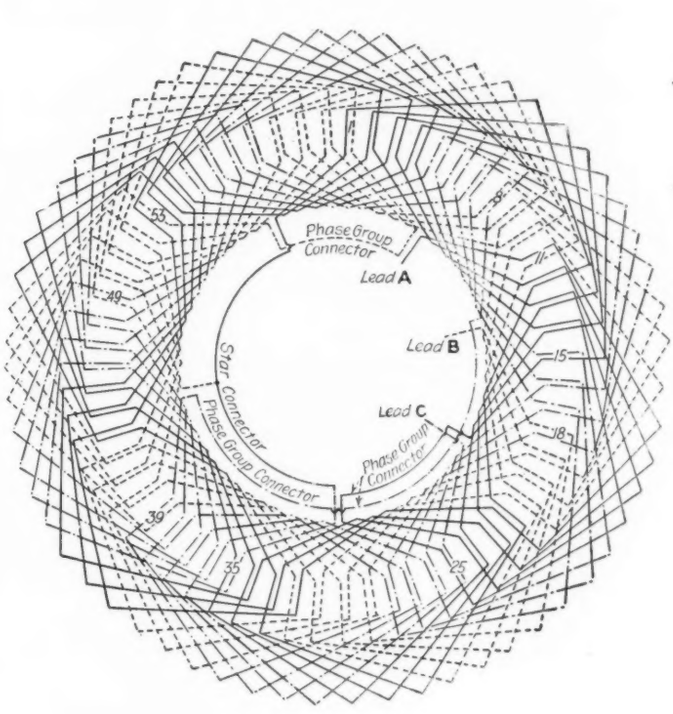
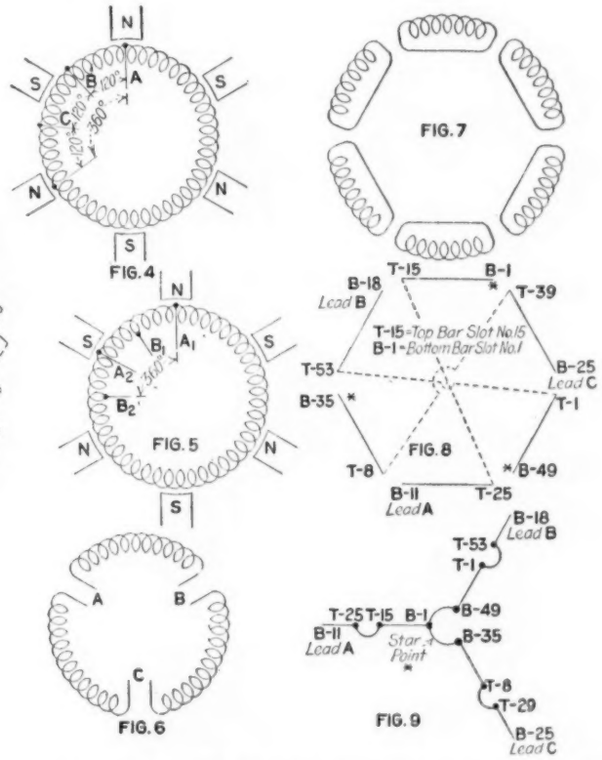


FIG. 3. THREE-PHASE, SIX-POLE WAVE WINDING DIVIDED INTO SIX SECTIONS AND CONNECTED SERIES STAR



FIGS. 4 TO 9. DIFFERENT SCHEMES FOR GROUPING THE WINDING SHOWN IN FIG. 3

Assume that a bar in the bottom of the slot 1 is connected by the connector on the back of the core to the bar in the top of slot 12, and that the front end of the bar in slot 12 is in turn connected on the front end of the core to the bar in the bottom of slot 22 and this again on the back end to the bar in the top of slot 33. Tracing the winding through in this manner, after one complete circuit has been made around the core it will be found to connect to the bottom bar in slot 2 and for the second round to the bottom bar in slot 3 and so on, until finally, when all the slots are traced through both top and bottom, the last throw will close the winding on itself by connecting to the front end of the bottom bar of slot 1. This can be proved easily by setting down a table of numbers 1-12, 12-22, 22-33, 33-43, 43-54, 54-2, 2-13, etc., representing the path of the winding around the core as described until each number has appeared 4 times, or until $2 \times 62 = 124$ bars have been passed through. This would then give a completely closed winding, and if the middle point of each end connector were attached to a bar on a suitable commutator, it would represent exactly a direct-current series armature winding.

To employ this winding on alternating current, the proper phase leads must be brought out, and this can be accomplished in several ways. One method of doing this would be to leave the winding closed and bring out three-phase taps 120 deg. apart, as shown in Fig. 4, or four taps, as in Fig. 5. The first would give three-phase and the second two-phase. A second method is to open the winding at three proper places and use these three pieces to form the usual star or delta connection. This is indicated in Fig. 6. It must not be assumed that the winding is actually interrupted at the points A, B and C since each portion of the winding between these points actually runs completely around the core several times. This can be readily grasped if the table as set down in the foregoing is separated into three parts, each part having one-third of the total bars in it, or $\frac{62 \times 2}{3} = 41\frac{1}{3}$; say 40 bars in one section and 42 bars in the other two. The slight unbalancing so caused is, in this case, of no consequence.

It is necessary to keep an even number of bars in each section for the reason that the connections are all on one end of the core and an odd number of bars in any section would mean ending that section on the back end of the core. Or, in other words, in tracing through

the winding on the odd-numbered bars one is always going from the front to the back and on the even-numbered bars always coming from the back to the front, hence to end on the front an even number of bars must have been passed through.

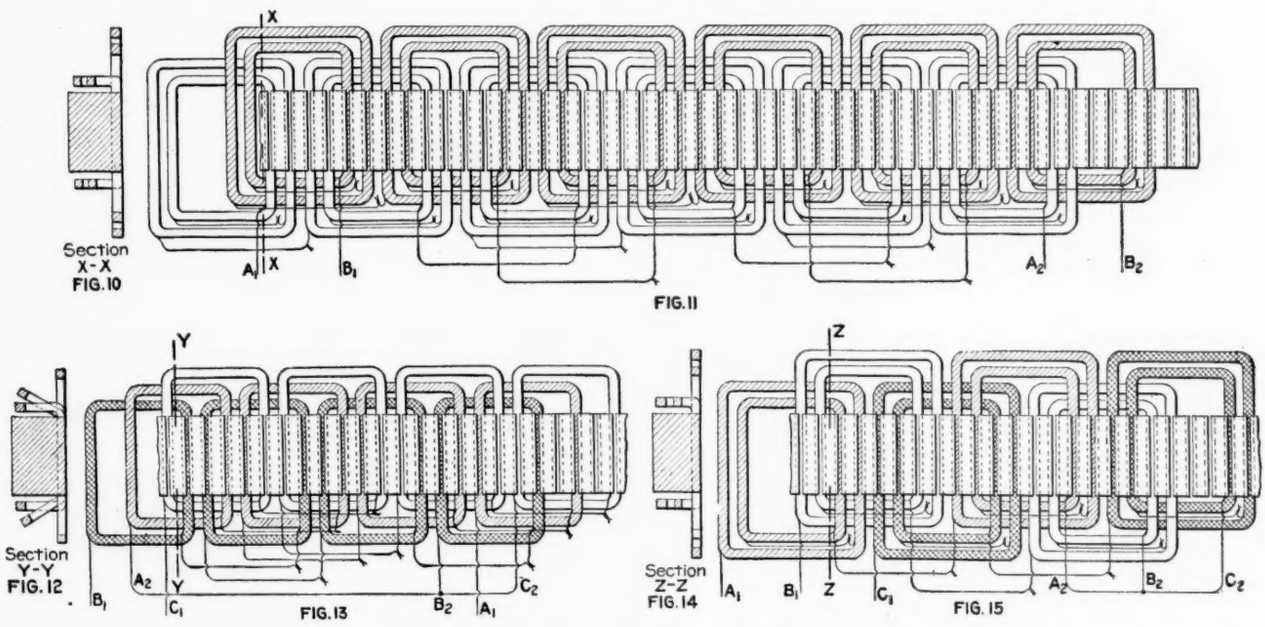
In the connection shown in Fig. 3 a still different method is adopted by separating the winding into six sections, four of which have 20 bars in them and two have 22 bars each. These six sections are connected in pairs in series and the three pairs connected in series star to form a three-phase winding. The reason for this is a more efficient use of the copper than either of the two preceding methods. This follows from the fundamental idea brought out in the first article of this series—that every induction motor is at the same time an alternating-current generator, due to the fact that the stationary windings are cut by the rotating field. The output of an alternating-current generator is measured by the product of the volts times the amperes. In Fig. 3 the copper will carry a certain maximum current. It then follows that to get the most out of it as an alternating-current generator, the windings must be made to generate the maximum practicable voltage, and this is the result accomplished by the connection in Fig. 3.

In the complete closed winding, Fig. 3, each coil is generating a small voltage which is slightly out of phase with all its neighbors. The situation can be described as a polygon having 62 equal sides, each side representing the voltage of a single coil. Obviously, the maximum voltage would be obtained if we could roll out this polygon into a straight line and use one-third of its length for each of the three phases. This cannot be done in practice, but it can be approached as shown in Fig. 7. Here the circle represents the 62-sided polygon just mentioned. By dividing the winding into six pieces, the effective voltage of each piece is reduced to the equivalent of one side of a hexagon. By putting the opposite side of the hexagon in series and then the three pairs in series star, the winding is made to develop almost the maximum voltage. A slight gain could still be made in the same way by dividing the winding in 12 pieces and using these 6 pairs as a six-phase winding, but this is too complicated for ordinary use.

The connection shown in Fig. 3 is obtained practically by setting down a table, as previously stated, including all the bars and then dividing it into 6 pieces as nearly equal as possible, keeping an even number of bars in each. In this case sections 1, 2, 3 and 4 have 20 bars and 5 and 6, 22 bars each. Section 1 is then connected with 4 for phase *A*, section 2 with 5 for phase *B*, and section 3 with 6 for phase *C*. The proper ends of these connectors for star and the leads can be determined from Figs. 8 and 9, the numbering on which corresponds to that on Fig. 3. A little practice in this way will suggest how different three-phase connections could be made for star or delta or series or parallel to accommodate different voltages and how corresponding two-phase or even six-phase connection, could be obtained.

In the pushed-through type of winding, previously described, the coil is formed in the shape of a U and the two branches are simultaneously pushed through the proper slots in the core, after which the ends are bent toward each other and the individual conductors connected in series. In the hand-wound type a single long wire is threaded around and back through two slots until the complete coil is formed. The completed coil is practically identical in the two types, and the completed winding takes the form shown in Figs. 10 to 14 inclusive. Fig. 11 is typical of a two-phase arrangement. The coils are concentric and there are two shown per group, but in practice on induction motors as high as five or even six have been used. The coils that are inside on one end of the core are outside on the other end, thus insuring symmetry and equal resistance in the two phases. Fig. 10 shows a cross-section of the core and coils on the line *XX* and indicates the relative position of the two banks of coil ends.

Fig. 13 shows a three-phase winding similar to the two-phase Fig. 11 except that only one coil per group is shown; however, there might be four or more con-



FIGS. 10 TO 15. DEVELOPMENT OF TWO- AND THREE-PHASE CONCENTRIC WINDINGS IN PARTLY CLOSED SLOTS

centric coils per group, as in the two-phase. It will be noticed at once from this figure and Fig. 12 that the winding is not so simple as the two-phase. Owing to the passing of the coils at the ends of the core, three banks, or tiers, are necessary instead of two, and the coil ends are correspondingly longer. It will be noticed that the *A* phase occupies the middle tier all the way through and the *B* and *C* phases are alternately in the inside and outside tiers. In this manner the resistance is kept nearly equal in the three phases.

In order to be able to wind the three-phase with a two-bank winding similar to the two-phase, the scheme shown in Fig. 15 is employed. It can be seen that there are the same number of slots as in Fig. 13 and that both are three-phase four-pole series-star windings. However, Fig. 15 has only two tiers at the ends and has two coils per group instead of one, but only two groups per phase instead of four. This is what is called a "consequent pole winding," because the current passes in the same direction through all the coils forming, for example, two north poles in each phase. Since there cannot be a north pole without a corresponding south pole, the magnetism returns between the groups in each phase, thus forming the two south poles, or four in all. This winding is simpler to make than Fig. 13, mechanically, but has some slight electrical disadvantages. Fig. 14 is a section through the core and winding on the line *ZZ* and indicates the relative positions of the two banks of coils.

Rearrangement of Concentric-Coil Windings

It will be seen that these concentric coil windings do not lend themselves readily to rearrangement or reconnection to different poles or phases, and this is one reason why they have gradually fallen into disuse. Two-phase windings such as Fig. 11 can sometimes be connected in "T" and run on three-phase, and mention of this will be made in a later article. Also, a comparison of Figs. 11 and 15 indicates that the winding in Fig. 11 might be connected for three-phase 8 poles by a consequent-pole connection similar to Fig. 15, since the total number of groups, being twelve, is half of 3×8, and this lines up with Fig. 15, where the total number of groups is 6, or half of 3×4.

Where the coils are of the closed type similar to "diamond" coils used in open slots, they may be grouped and connected by the usual diagrams for that type, which will be discussed under open-slot windings. There is, however, a large class using one- or two-turn coils of the open end, or "wave," type which form very interesting windings, two of which are shown in Figs. 1 and 2. This type of winding is believed today to be the form best adapted to the rotating member of phase-wound motors up to the largest sizes. Since they are perfectly symmetrical, they can be equally well employed in the stator, where the design permits a number of conductors not exceeding four per slot. These diagrams are practically self-explanatory, but their great utility and wide employment merits a brief comment. They are typical three-phase diagrams connected both star and delta. Three-phase is chosen as it is suitable for either stator or rotor and is oftenest met with. Fig. 1 shows a four-pole series-delta winding, but it may be equally well connected parallel-star. The winding, Fig. 1, has four conductors per slot. In Fig. 2 is an eight-pole series-star connection where the two wires in the top of the slot are connected in parallel, also the two in the bottom of the slot, to form one conductor, or a total of two conductors per slot.

In these windings it is of interest to note that the number of cross-connections is a minimum, being reduced to the star or delta connection, the leads and one short connection in the middle of each phase. Such conditions are ideal for a rotor, and when the coils are placed in a slot with the tip overhung from one side, the winding forms one of the best mechanical jobs for a rotor that is known at the present time.

Dillon Boiler-Tube Blower

There have been numerous tube blowers perfected, many of which have merits particularly their own. Another one that will be of interest to engineers is the Dillon auto-

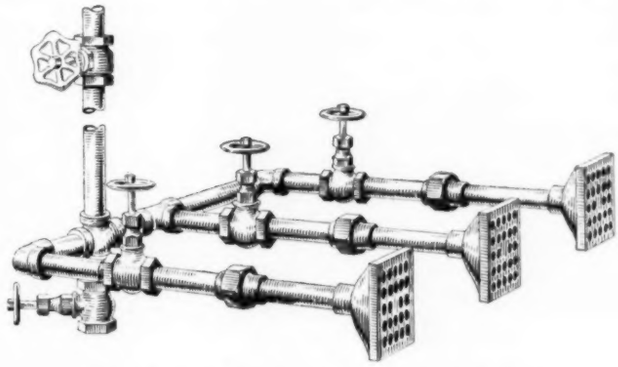


FIG. 1. PIPING OF TUBE-BLOWER HEADS

matic flue blower, made by the A. S. Dillon Automatic Flue Blower Co., Kansas City, Mo. This device consists of two or more blower heads piped into the rear connection of the boiler so that they come about 12 in. from the rear head. The general design and arrangement of the heads are shown in Fig. 1. Steam enters through the vertical pipe and passes to the blower heads through the branch

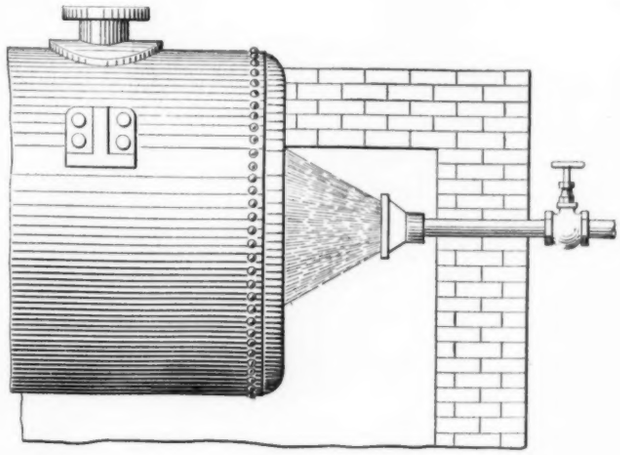


FIG. 2. BLOWER HEAD IN REAR CONNECTION

pipes, all of which are fitted with valves. A drip pipe provides means for draining off condensation before blowing the tubes. Each head is capable of cleaning 20 tubes. As the blowing heads are placed at the rear end of the boiler, Fig. 2, the soot is blown through the tubes with the natural draft toward the front end.

Steam-Engine Troubles—Rod Ends

By H. Hamkens

SYNOPSIS—Different designs of stub or rod ends, valve bonnets, valve steam stuffing boxes and packing and several methods of keying the stem to the steam arm are described and their relative merits considered. A summary of good things to look for in an engine is given, but this article does not complete the series.

The ends of the valve rods must be turned and the right- and left-hand threads cut between centers on a lathe. To do this work on a screw machine or turret lathe would be detrimental to the valve gear, since the threads would not be in line with one another. The rods must fit well in the stub ends and the face of the check nuts must be square with the thread. Special nuts turned and threaded in a lathe should be used, and they should have a sleeve, as shown in Fig. 159, to protect the thread on the rods from getting bruised. They should be case-hardened. Commercial nuts are not fit to be used in this class of work. Careful attention should be paid to these small details on which much of the life of an engine depends.

Some of the older designs of stub or rod ends, shown in Fig. 160, are troublesome. The one marked *A* is made of bronze, in two parts bolted together. The only way to adjust it for wear is to remove the cap and reduce it by filing or scraping; this is the worst thing ever devised for the purpose. The stub end *B* is made of bronze, and is provided with a loose half-box, adjusted by a steel wedge. Since most stub ends act by pulling, the greatest wear will be on the body itself, a renewal of which is rather expensive. That shown at *D* consists of the main part and cap, made of brass and held together by a steel strap with gib and key—a complicated and troublesome construction. *C* is of the same order except that it has a bolt instead of the gib and is adjusted by a setscrew on the top, which is a good feature.

The stub ends shown in Fig. 161 are of modern design, are suitable for higher engine speeds, and the adjustments are simple. That at *E* is made of bronze, with a loose box and wedge which may be graduated for accurate adjustment. There is but one objection to this design—the wear of the hole in the stub end itself. The one at *F* is of bronze, with a loose box and screw adjustment in the top. The body of this stub end is also subject to wear. *G* is made of malleable iron, bronze or forged steel, preferably the last, with a bronze bushing and screw adjustment on the top. A small dowel pin keeps the bushing from turning. The latter is split on one side

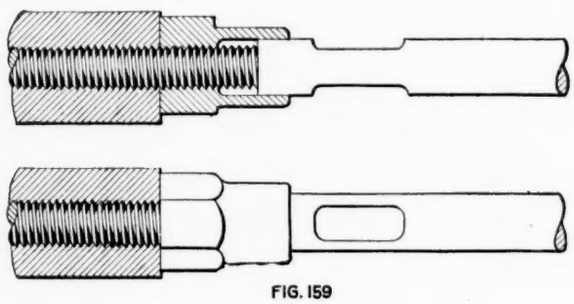
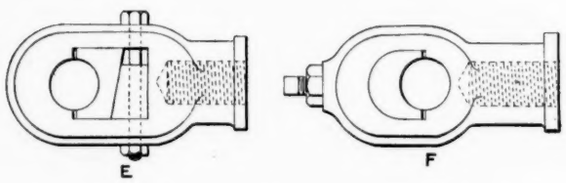


FIG. 159



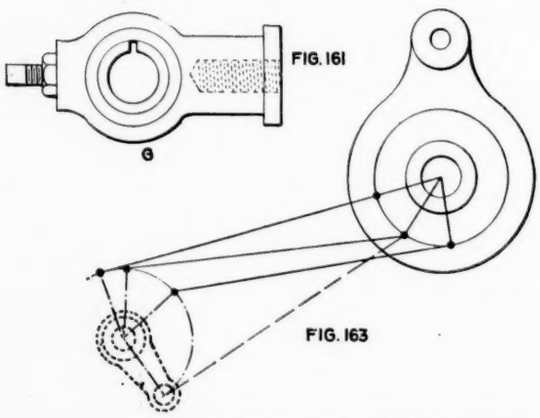


FIG. 161

FIG. 163

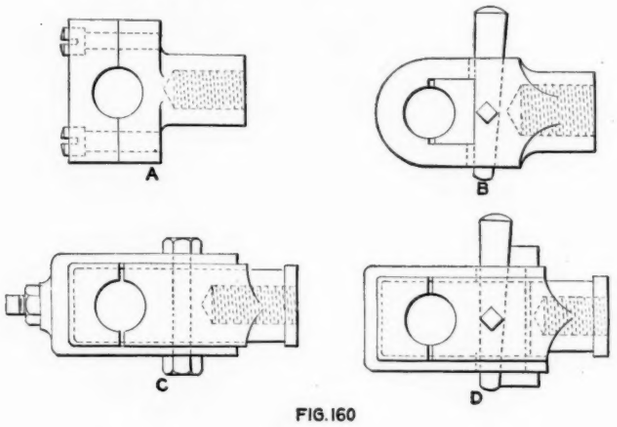


FIG. 160

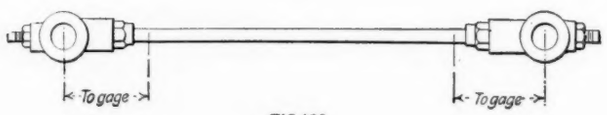


FIG. 162

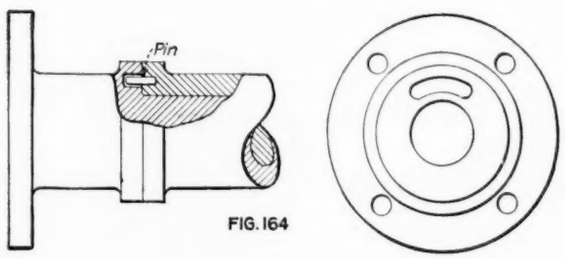


FIG. 164

FIGS. 159 TO 164. SECTIONAL AND OTHER VIEWS OF CORLISS-ENGINE VALVE-GEAR PARTS

Fig. 159—Showing special nut forming sleeve for rod end. Fig. 160—Some old designs of rod ends. Fig. 161—Modern rod end designs. Fig. 162—Center punch marks for checking wear on rod ends. Fig. 163—The dotted line shows how the exhaust rod may drop down out of position. Fig. 164—Pin in wristplate to prevent it oscillating too far

only, and as it wears the setscrew can be tightened. This is open to criticism from a theoretical standpoint, but it works well in practice.

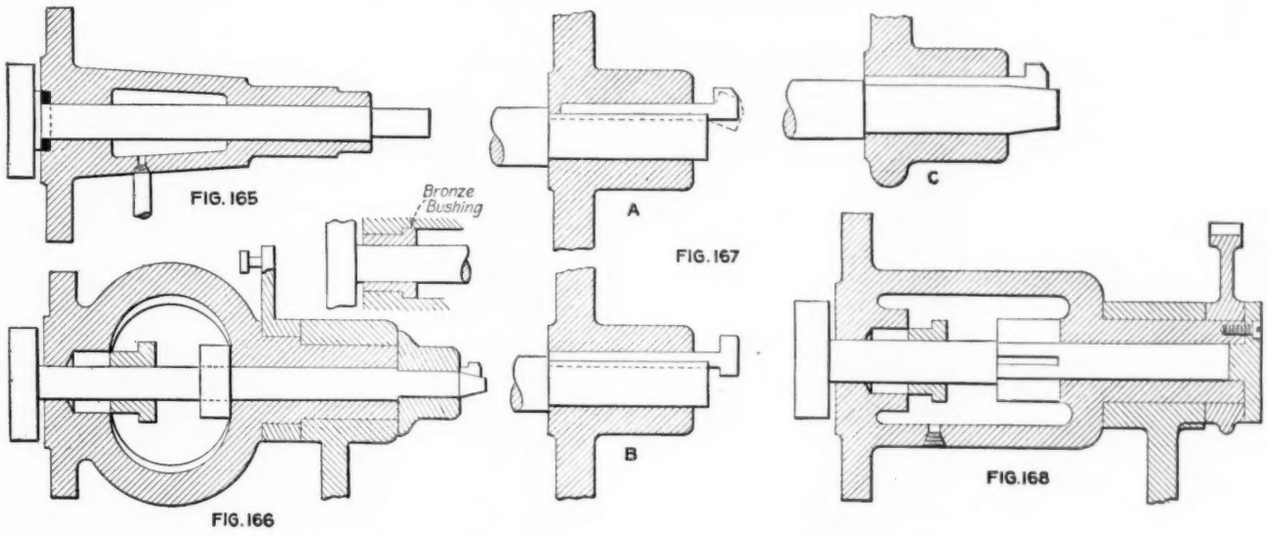
As valve settings, through wear and adjustment of the stub ends, undergo certain changes which affect the rod centers, it is advisable to provide a simple check which can be verified at any time. This can be done by marking the valve rods, parallel and eccentric rods, etc., with a center punch any convenient distance, say three or four inches, from the center of the pins, as in Fig. 162. A gage can be made for the fixed distance, or a pair of dividers may be used. Simple as this is, it will save a lot of time, trouble and uncertainty.

It will sometimes happen on the wristplate motion that the wristplate is moved over too far by hand and the exhaust lever drops down, as shown in Fig. 163. If this occurs without being noticed, the engine will perform some strange antics when the steam is turned on and very likely something will be broken or twisted. As a precaution against this, a pin is screwed into the back of the wristplate hub which works in a slot of sufficient length, either milled or cored in the face of the wristplate stand, as shown in Fig. 164. The slot and pin will prevent the wristplate from oscillating too far on either side, but of course the operator must be careful in adjusting the length of the hook rod or eccentric rod; otherwise the pin may be sheared off. There must be some play allowed to guard against accidents.

The bonnets, or as they are often called, the valve brackets, are important members of an engine, since most of the valve-gear parts are supported by them. Some designs give trouble which, with a little care and forethought, could be avoided. The stuffing-box and bearings seem to be the vital points. Attempts have been made to omit the stuffing-box and to substitute a collar and friction disk on the valve stem which bear against the inner surface of the bonnet, as in Fig. 165, where they are beyond the control of the engineer. To lubricate the collar properly is impossible; it will keep on grinding away until worn out. For low pressures and slow speeds the arrangement may have worked fairly well, but it does not answer for present-day requirements.

The combination of bonnet and stuffing-box shown in Fig. 166 is often used. It works all right for a while, but will eventually give trouble in the short bearing back of the stuffing-box. The valve stem must have a close working fit at that place; with the short bearing a groove will be cut around the stem, due to the resistance of the valve in rocking to and fro. A renewable bronze bushing equal in length to the diameter of the valve stem should be inserted in the bottom of the stuffing-box, as shown in the detail sketch above Fig. 166. The bushing should be made a close working fit on the stem, avoids the cutting of the stem by the narrow bearing, and is renewable.

The question of packing for the valve stems is problematic. There are metallic valve-stem packings galore on the market, but none of them has met with unqualified success. If a valve stem could be kept central and rotating without any side motion, metallic packing would be all right, but its quick jerky motion combined with a certain amount of vibration gives the steam a chance to work its way through. Plastic soft-metal packing made into suitable rings and forced lightly into the stuffing-box by the gland is about the best thing for packing Corliss valve stems. Fibrous packing cannot be recommended; it will get hard, wear the stem and need frequent renewal.



FIGS. 165 TO 168. SECTIONAL VIEWS OF CORLISS-ENGINE VALVE BRACKETS

Fig. 165—No stuffing-box is used. Fig. 166—See detail, showing bronze bushing in bottom of stuffing-box. Fig. 167—The key should not project as shown at A. Fig. 168—Made to relieve strains of the ordinary overhanging bracket

Of the three ways of keying the steam arm to the valve-stem shown in Fig. 167, *A* is apt to cause trouble if the key has to be taken out, as the head, being unsupported underneath, will bend over as shown in dotted lines if the key is in tight. The tee-head key shown in *B* is not much better unless two wedges are used to force it back. In *C* the valve stem is extended, with a long taper, giving the head of the key a good support. This is the most approved method.

Fig. 168 shows a design of bonnet in which the steam arm, ordinarily placed at the extreme outer end of the valve stem, is located inside of the bonnet so as to eliminate strains due to the overhanging arm by placing it between two bearings instead of outside of one. Except for large engines the change cannot be recommended, since the arm is less accessible. This design is well suited to heavy engines in rough service.

The valve-gear pins are subject to considerable wear. They have a tendency to wear out of round, which makes it difficult to adjust the stub ends properly. They should be case-hardened and ground, reducing the wear to a minimum.

Summary of Desirable Features

Having explained engine troubles in general, suggested remedies and criticized existing designs, the following summary gives in condensed form the most desirable features that should be incorporated in a modern Corliss engine:

One-piece heavy-duty frame with bored guides, full bearing on the foundation, oil channel around the base, solid bottom in the crank pit, wedge adjustment and chain oilers for the main bearings.

High outer bearing with chain oilers.

Counterbalanced disk crank.

Openhearth-steel shaft with long tapers for reduction in diameters.

Solid-end connecting-rod with wedge adjustment, leaving distance between centers constant.

Cast-steel crosshead with wedge-shaped babbitt-lined shoes, and clamping device.

Double-ported cylinder with exhaust ports located partly in the cylinder bore to reduce clearance, round ends, steel lagging filled with 85 per cent. magnesia.

Piston with two-piece junk ring, lined with red metal strips, snap ring and follower.

Openhearth-steel piston rod with collar and nut at the piston end, thread and check nut at the crosshead end.

Metallic packing for the piston rod.

Double-ported steam and exhaust valves; steam valves to open inward.

Throttle valve of globe pattern.

Sole plate under cylinder and valve gear.

Double-eccentric parallel-motion valve gear without wristplates, with gravity latches without springs; pins hardened and ground.

Telescopic hook rods.

Inverted vacuum dashpots with ball joint.

High-speed centrifugal governor with one tension spring, oil-tight casing, oil-bath lubrication, adjustable oil pot.

Oil guards for crank and eccentrics.

Continuous gravity oiling system with filter, tank and pump for circulation.

Automatic safety stop.

[*The next article treats of engine foundations.*]

A Queer Insulation Failure

By M. A. Walker

The insulation of the field windings of a frequency changer broke down at frequent intervals and always at about the same place. The machine in question was a 2000-kw. set used for changing the frequency from 25 to 60 cycles and vice versa. The set was of the vertical type, with the 25-cycle machine nearest the step bearing, the 60-cycle unit next, with the exciter at the top of the shaft. The field windings of the 25-cycle synchronous machine were giving the trouble.

Arriving on the job where this machine was installed, the first thing was to obtain a complete history of the case, which was this: The field winding broke down at regular intervals and always in the same place, but sometimes on different polepieces. The unit had been started by throwing it on a compensator or auto-transformer at about half normal voltage with the field winding open-circuited. The field windings had failed five or six times within a year and a half. One of the theories advanced was that the trouble was caused by excessive vibration and mechanical stresses due to the current inrush and magnetic stresses at starting, which caused a movement of the windings that resulted in abrasion and final failure of the insulation. Another theory was that a high potential was induced in the field winding when the starting voltage was first impressed upon the stator of the motor. As this high potential occurred every time the machine was started, the insulation became gradually weakened until at last it broke down. Based upon these two theories, the latter reasonable, the former more likely to apply to the stator windings than to the rotor or field winding of the synchronous motor, the practice of starting from the auto-transformer was abandoned and starting from the direct-current tried by using the exciter as a motor.

The Problem Apparently Solved

With the elimination of the supposedly high induced voltages in the motor field winding and absence of severe and sudden stresses due to self-starting of the synchronous motor, it was expected that all trouble would cease, and the machine was put back into service, everyone feeling that the problem had been solved. About three months had elapsed when the field failed again. This time, when the field windings were taken out for repairs, it was found on examination that the insulation of two polepieces was badly disintegrated and charred, in both instances at the forward end; that is, in the direction of rotation. The wooden distance pieces between the last turn of the winding and the pole tip were also charred. There was a strong odor of burnt wood and insulation, and also a pronounced odor of sulphuric acid. Attention naturally turned toward locating the source from which the acid came. Going down into the step-bearing chamber, which also contained the oil pump and oiling system for the step bearing, it was found that a ventilating pipe from a large storage battery in an adjacent room, passed through and immediately underneath the step bearing of the frequency changer. A closer examination showed that this pipe leaked and thus permitted acid-laden fumes to escape into this chamber instead of exhausting outside the station. Normally there was very little acid escaping into the chamber under the machine since it could more easily escape into the air. It was a very different matter, however, when the machine was running, since the acid-laden fumes were then drawn into the rotating element of the frequency changer as if by induced draft. Moreover, the worst condition was when the battery was being charged and gassing and when the frequency changer was also operating.

Finding the leak in the ventilating pipe from the battery room seemed to be a solution to the repeated insulation failures. The pipe was repaired, as was also the field coils, and the machine placed back in service, with permission to start up either way that was most convenient. More than a year has passed, but no trouble has developed. This incident is particularly interesting in that it proves that it is best never to draw conclusions hastily, especially in cases of electrical trouble.

Steam Engineer's License Examination—VI

By H. F. Gauss

SYNOPSIS—Operation of the Meyer expansion or cutoff valve in detail. Instructions for setting this type of valve and how to apply the Zeuner-valve diagram. Methods of balancing the slide valve.

The Meyer expansion valve consists essentially of an ordinary slide valve provided with lap, lead and an eccentric having the proper angle of advance. The ends of the main valve are provided with passages through which the steam enters the cylinder ports. These passages in no way interfere with the operation of the main valve as a simple slide valve; they merely form ports over which a secondary, or expansion, valve operates, which is actuated by a separate eccentric. To understand clearly the operation of this type of valve, it would be well to construct a model similar to those described in a previous article. Fig. 1 shows a diagram of such a model. The main valve with the cutoff or expansion valve working on its back is clearly shown, as well as the relative positions of the two eccentrics. Fig. 1 shows the engine on head-end center; Fig. 2, at cutoff (at about 0.3 stroke); Fig. 3, at one-half stroke; and Fig. 4, on the crank-end center.

Frequently the expansion valve consists of two blocks, drilled and tapped, one with a right-hand thread and the other with a left-hand thread. The valve stem is provided with corresponding right- and left-hand threads and projects through the head end of the valve chest. On this projecting end a handwheel is keyed so that the stem may be turned, and thus the distance between the two blocks altered. A study of the diagrams makes it plain that to increase the distance between the blocks would cause cutoff to occur earlier in the stroke, while to decrease this distance would cause cutoff to occur later.

Procedure in Setting a Riding Cutoff

To set the expansion valve, first set the main valve as an ordinary slide valve; that is, equalize the lead at each end of the stroke. Then with the main valve in mid-position, see that the expansion valve travels equal distances to either side of its central position on the back of the main valve. Make all adjustments to secure this with the expansion-valve stem or eccentric rod. Separate the blocks to their extreme position, which, as stated, gives earliest cutoff. Place the engine in the position at which earliest cutoff is desired, and bearing in mind that at earliest cutoff the main valve and expansion valve are traveling in opposite directions, revolve the cutoff eccentric around on the shaft until the outside edge of the cutoff valve is line-and-line with the outside edge of the port in the main valve. Fasten the cutoff eccentric to the shaft, check up the opposite end of the cylinder, and the valve is set. Should the cutoff valve consist of a single plate, it is not adjustable, but is set by proceeding as described with the omission of the steps pertaining to altering the distance between the blocks.

This method of setting the expansion valve is based on the assumption that the earliest point of cutoff possible is known, as well as the corresponding distance between the cutoff blocks of the expansion valve. If these quantities are not known, a different method will have to be followed. The following points should be borne in mind:

1. If the engine is reversible—that is, if it runs at times in either direction—the cutoff eccentric should be set 180 deg. ahead of the crank, or opposite the crank when the latter is on dead-center.

2. Care must be taken to see that the cutoff valve does not reopen the port in the main valve before the main valve has covered the steam port in the cylinder.

3. Because of the angularity of the eccentric rods it is necessary to equalize the cutoff for both ends of the cylinder by adjusting both the angle of advance and the eccentric rods or valve stems.

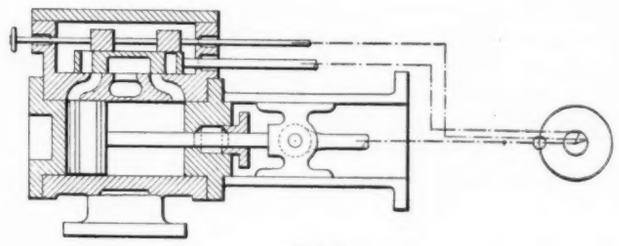


FIG. 1

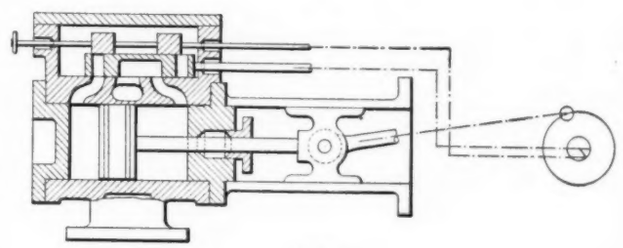


FIG. 2

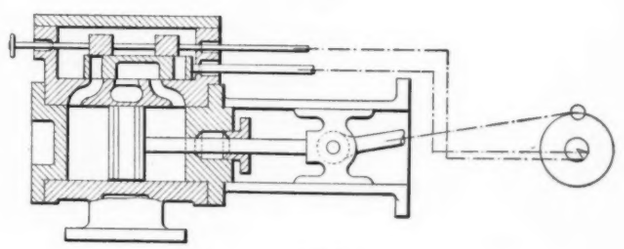


FIG. 3

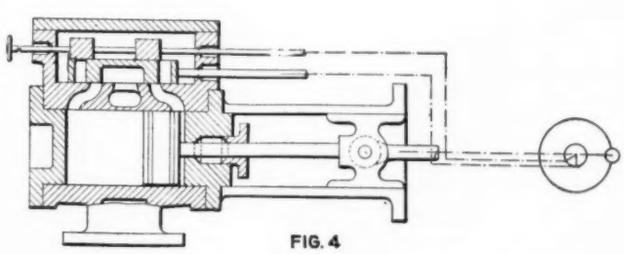


FIG. 4

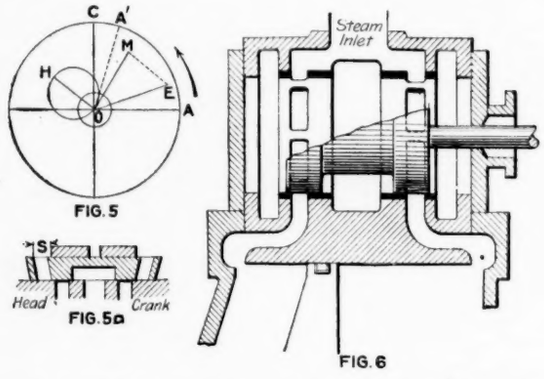
FIGS. 1 TO 4. MEYER EXPANSION VALVE-GEAR

Fig. 1—Engine in head-end position. Fig. 2—Valve positions at cutoff. Fig. 3—Piston at mid-stroke. Fig. 4—Engine at crank-end center

To set the valves, first, as before, set the main valve as an ordinary slide valve by equalizing the lead. Then see that the cutoff valve travels equal distances to either side of the center line of the main valve when the latter is in mid-position. Now, if the cutoff-valve blocks are adjustable, separate them to their extreme position, and starting with the cutoff eccentric about 170 deg. ahead of the crank, revolve the engine in the direction it is to run and observe whether the cutoff valve reopens the port in the main valve before it closes the main steam port. If this reopening does not occur, increase the angular advance of the cutoff eccentric until a position is found at which reopening is about to occur, making allowance for at least $\frac{1}{8}$-in. steam seal. Observe the point at which cutoff takes place and equalize it for both ends of the cylinder. Thus the position of earliest cutoff is determined, and by bringing the blocks of the cutoff valve together, cutoff is made to occur later in the stroke.

In the volume on "Valve Setting," of the Power Plant Library, Hubert E. Collins devotes an interesting chapter to expansion valves.

To apply the Zeuner-valve diagram to the expansion valve proceed as in Fig. 5. With a convenient radius describe a circle representing the crank circle. Draw line *OM* of a length equal to the eccentricity of the main eccentric and making an angle *COM* with the vertical, equal to the angle of advance. Draw line *OE* of a length equal to the eccentricity of the cutoff eccentric and



FIGS. 5 AND 6. ADJUSTING A RIDING CUTOFF BY ZEUNER'S DIAGRAM

Fig. 5—Zeuner diagram applied to Meyer cutoff valve. Fig. 5A. Main and cutoff valve in central position. Fig. 6—Indirect piston valve

making an angle *COE* with the vertical, equal to the angle of advance. Draw *OH* equal and parallel to *EM* and on *OH* draw a circle. The construction is such that, starting with the crank at *A* and revolving with the arrow, the distances intercepted on the crank center line *A"A*, between *O* and the circumference of the circle *OH*, is the distance between the center lines of the main and cutoff valves.

Fig. 5a shows a cutoff-valve gear in such a position that the center lines of both the main and the cutoff valves coincide. Evidently before cutoff can occur in the head end, the valves must move relatively a distance *S*, the lap of the cutoff valve. Returning now to Fig. 5, if a lap circle is drawn with its center at *O* and with a radius *S* (Fig. 5a), the crank position at cutoff is determined by the intersection of this lap circle with the circle *OH;* namely, *OA'*. These figures are not to scale, as they are merely intended to indicate the construction. As *S* becomes smaller, cutoff occurs earlier, and when the cutoff valve closes the port in the main valve (in the position in Fig. 5a) and extends over the far side, the lap becomes negative and the crank center line *OA* must be produced through *O* in the diagram, Fig. 5, and the intercept at cutoff read on the portion of circle *OH* below *A"A*. The value of the diagram in Fig. 5 is apparent, but it should be borne in mind that no allowance for the angularity of the eccentric rods is made, and in setting an expansion valve according to results obtained from a diagram, the cutoff must be equalized for each end of the cylinder as before pointed out. That is, for every different angular advance of the cutoff eccentric the eccentric rod will have to be altered slightly to keep the cutoff at the same point in each stroke.

A great drawback to the use of the plain slide valve is that with full steam pressure on the back of the valve,

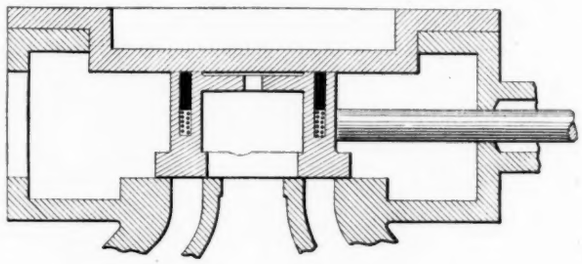


FIG. 7. BALANCED SLIDE VALVE

the friction between the valve and its seat is so great that a large amount of energy must be expended to move it. In fact, the force required to move the valve is so great that it is almost impossible to design a shaft governor that will control the valve within a satisfactory range of speed.

The balanced slide valve has been designed to overcome this difficulty. The most perfect form of balanced slide valve is the piston valve having equal steam pressure on the ends and none on the sides. However, the horizontal form of piston valve rapidly wears out of true and unless provided with some kind of packing ring, leaks badly. The vertical valve is not subject to this defect.

Another objection to the piston valve is the large amount of clearance volume necessary, which reduces the economy of the engine.

Fig. 6 is a sketch of a piston valve. This is an indirect valve, steam being admitted past the inside edges of the port and exhausted past the outer edges.

A second form of balanced valve consists of a heavy pressure plate held in place by a steel spring when the engine is not running and by steam pressure when the throttle is open. This pressure plate is held off the seat by narrow strips, carefully fitted, so as to allow the valve to work between the seat and the plate without permitting the leakage of steam. Satisfactory results may be obtained if the strips are scraped as the valve wears down, so that the fit of the valve between the seat and the plate may be kept tight.

Still another form of balanced valve consists of a pressure plate bolted rigidly to the steam-chest cover. The valve itself is provided with a groove around its back, in which a packing ring fits, held out against the plate by springs. The space inclosed between the

back of the valve and the packing ring is connected to the exhaust passage, thus greatly reducing the pressure on the back of the valve. Fig. 7 illustrates this type of balancing.

There are other methods of balancing slide valves, but those mentioned are typical. The primary object sought in balancing the slide valve is to reduce to a minimum the force required to move the valve. It is of the utmost importance that this force be small when the valve is driven and controlled by a shaft governor. The reason for this is evident, being simply that the greater the resistance a valve offers to being moved the greater will be the variation in speed before the governor can develop force enough to make it respond.

The automatic cutoff class embraces all engines in which the steam distribution in the cylinder is under the control of a governor which automatically varies the eccentricity or angle of advance or both, thus altering the events of the stroke to suit the work required to be done in the cylinder, and maintaining a constant speed.

The action of this type of valve will be considered in a study of shaft governors and need not be treated here.

Hazardous Industrial Occupations

By Chesla C. Sherlock

It is a well-settled rule of law that where a servant is engaged in a hazardous occupation it is the duty of the master to explain to him the nature of the dangers to which the work will regularly and normally expose him and the most effectual means by which to avoid them.

It is obvious that under the complex industrial methods of modern times it would be impossible for the master to personally warn all his servants. Especially would this be so in large industrial centers where thousands of men are constantly employed. The courts have said that inasmuch as this duty rests with the master, it is not discharged by merely delegating its performance to an agent.

As early as 1893 it was said that if the master cannot personally perform this duty, he must secure the services of a thoroughly competent and trustworthy person to do it for him. In later years this doctrine has given rise to what is known at law as the doctrine of vice principal, and this employee who, in the absence of the master, is charged by duty to warn his fellow servants of the usual dangers of his employment, is known at law as a vice principal. If the vice principal is negligent and fails to perform his duties, the master is deemed to have been guilty of negligence himself and he is held responsible for a failure to exercise this duty. In one case the court said:

> It is more reasonable to hold that where the danger was known to the master and unknown to the servant, the master should be held to see to it that the servant, when put upon work which exposes him to danger, should be informed of it. The master must not expose his servant to an unreasonable risk. Where the servant is as well acquainted as the master with the dangerous nature of the machinery or instrument used, or of the service in which he is engaged, he cannot recover. But where the master employs a servant in the use of machinery which he knows, but the servant does not know, to be attended with peculiar danger, we are all of the opinion that he must be held responsible for an injury which occurs in consequence of his failure to see to it that a proper notice is given.

The real difficulty in cases of this kind is where the principle of vice principal is invoked. Just how far is the master or his immediate representative, the vice principal (usually a foreman or superintendent), bound to go in instructing the servant? A Massachusetts court, speaking in this particular, said:

> An employer is under no obligation to warn an employee of dangers which are obvious, nor to instruct him in matters which he may fairly be supposed thoroughly to know.

It would seem, then, that even though the servant were engaged in a hazardous occupation, there would be no immediate necessity for a warning to him if he were an old and experienced employee who was thoroughly familiar with the nature of his work and the reasonable risks attendant thereto.

The duty devolving upon the master or upon his representative generally extends only to inexperienced employees or those who are new to the particular phases of the work which they are asked to do and consequently are not familiar with the reasonable risks of such work.

Since the courts have found under modern conditions that they cannot hold the master personally chargeable with the duty of warning all his employees, they have placed that duty upon his vice principal. In order that there may be no confusion as to what the courts mean by a "vice principal," we will say that he is generally the man in authority immediately over the servant or employee. He may thus be foreman, manager or superintendent, as the case may be.

Courts Oppose Doctrine

Some of the courts, however, have taken a strenuous opposition to the doctrine that the duty of the master to warn his servants of the risks of their employment can be delegated by him to another. One court, in supporting this contrary doctrine, said:

> It is the duty of the master to use reasonable care to provide for the servant, so far as the work at which he is engaged will permit, a reasonably safe and proper place in which to do his work, and to that end, if the place may become dangerous by reason of perils arising from the doing of other work pertaining to the master's work, different from that in which the particular servant is engaged, to give him such warning of the additional dangers as will enable him, in the exercise of reasonable care, to avoid them or to guard himself against them. . . . Whatever means are employed, it is the duty of the master to employ them. And that duty cannot be delegated to another person. . . . It remains the duty of the master, and the person employed to perform it is the alter ego of the master, for whose negligence the master is liable.

Under the workman's compensation acts many of the duties formerly imposed upon employers are, in a measure, abrogated or modified. The great conflict in these statutes is at once confusing and disconcerting. In many states, for instance, the employer is absolutely prohibited from pleading as a defense to an injury the old doctrines of assumption of risk, the fellow-servant rule and the doctrine of contributory negligence. In some instances the states have abolished one or all of these relics of the common law; in others the doctrine of comparative negligence is followed. That is to say, where both master and servant have been negligent and injury results to the servant, the negligence of the two parties is compared and the loss falls on the greater. Here the duty to warn is clearly in force. And, indeed, it might be said that the duty to warn is not entirely abrogated in any of the states where workman's compensation is in force.

The uncertainty arising under these laws has led to a wide difference of opinion and belief as to their real effect. In substance all the compensation acts have done

is to take away some of the employer's common-law defenses, provide a uniform scale of compensation for injured employees and defeat the employer's chances, so far as possible, of escaping liability by long and costly litigation.

We are of the opinion, then, based upon a careful consideration of the law in this respect, that the duty of a master to warn his employees engaged in hazardous occupations still exists. Certainly, humane treatment would demand it, if nothing else.

An employee cannot have compensation where he willfully inflicts an injury upon himself. To be willful, such injury must be the result of knowledge of danger and the probable consequences thereof. Where an employer has warned his employee of a danger arising out of a hazardous occupation and the employee deliberately commits the forbidden act and is injured, is such injury not willful?

The weight of authority seems to support the doctrine, then, that the master is bound to warn the employee who is engaged in hazardous occupations, of the reasonable risks of his employment; that this duty cannot be delegated by the master to the extent that he can escape liability therefor, although the majority of the courts hold that its performance can be delegated to a vice principal, but that the master will be liable for any negligence as to its performance by such agent or representative.

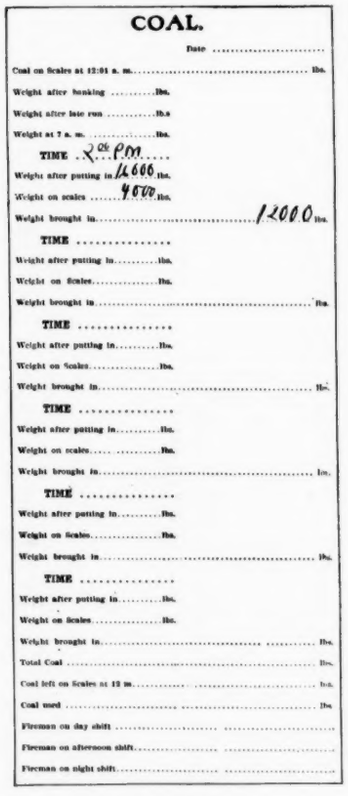
This is an important point of the law—a narrow one to be sure, but one that is of vast consequence in modern industrial relations. It has been treated briefly in the hope that it might be more profitably handled for the benefit of the interested but hurried reader.

Record Sheets of a Small Central Station

By O. J. Richmond

Herewith are shown station-record blanks designed for use at the station I am operating. The plant furnishes power for a street railroad and for several of the local shops, as well as light for a neighboring town nine miles away. In general the plant consists of two Curtis turbo-generators and four water-tube boilers. These sheets I believe are self-explanatory except the coal-record sheet. Coal is wheeled directly upon a platform scale which has a large steel pan. Firing is done by hand, coal being taken directly from the scale. If there is coal on the scale at the time of wheeling, it is weighed before filling the scale and put down in the second line as per record, say 4000 lb. on scale. The scale is then filled and weighed and the pounds, say 16,000, is put down and 4000 subtracted; this gives the amount brought in, or 12,000 lb. At 12 midnight all of the unused coal is on the scale. This gives, by adding the right-hand column, the total amount consumed, which is entered on the lower part of the large sheet. This sheet works out very well at our plant—gives all we want to know without any of the unnecessary items that so many logs seem to be burdened with. The sizes of the sheets are 16 x 8, 12 x 5 and 6 x 8 in.

[We receive many requests for record and report forms; but ordinarily we do not recommend any specific form, and rarely do we publish them. Every plant must adapt its forms to its own peculiar needs, and in the simplest manner possible.—Editor.]



COAL.

Date .....

Coal on Scales at 12:01 a. m. ..... lbs.
Weight after banking ..... lbs.
Weight after late run ..... lbs.
Weight at 7 a. m. ..... lbs.
TIME 2 PM
Weight after putting in 16000 lbs.
Weight on scales 4000 lbs.
Weight brought in ..... 12000 lbs.
TIME .....
Weight after putting in ..... lbs.
Weight on Scales ..... lbs.
Weight brought in ..... lbs.
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Weight brought in ..... lbs.
TIME .....
Weight after putting in ..... lbs.
Weight on Scales ..... lbs.
Weight brought in ..... lbs.
Total Coal ..... lbs.
Coal left on Scales at 12 m. ..... tons
Coal used ..... lbs.
Fireman on day shift .....
Fireman on afternoon shift .....
Fireman on night shift .....

DANBURY & BETHEL ST. RY. CO.
DAILY RECORD
POWER STATION
DAY ENDING 12:00 MIDNIGHT 191

WEATHER
BAROMETER
AVER. TEMP.

	TEMPERATURES HEATERS H SUP.	H DIS.	CONDENSERS NO. 1 INL.	NO. 1 DIS.	NO. 2 INL.	NO. 2 DIS.	VAC. NO. 1	NO. 2	BOILER PRESSURE	WATT METER READINGS	K. W.	BUS. VOLTAGE	K. W. H. SHOP LINE
MID. A. M.													
1. 00													
2. 00													
3. 00													
4. 00													
5. 00													
6. 00													
6. 30													
7. 00													
7. 30													
8. 00													
9. 00													
10:00													
11:00													
12:00 M.													
1. 00 P. M.													
2. 00													
3. 00													
4. 00													
5. 00													
5. 30													
6. 00													
6. 30													
7. 00													
8. 00													
9. 00													
10:00													
11:00													
12:00													
TOTAL													

SUPPLIES CONSUMED		
COAL		LBS.
CYL. OIL		QTS.
ENG. "		"
WASTE		LBS.
GREASE		"

GENERAL	
K. W. H.	
FUEL	LBS.
COAL PER K. W. H.	"

COAL, CAR NOS.	DATE REC'D	DATE UNLOADED

SUPPLIES RECEIVED

BOILERS OPERATED	FROM	TO	TOTAL HOURS
NO. 1			
NO. 2	"	"	
NO. 3	"	"	
NO. 4	"	"	

POWER OFF---CAUSE

NO. 1 TURBINE OPER.	
NO. 2 " "	
NO. 1 ROTARY OPER.	
NO. 2 " "	
NO. 3 " "	

REPAIRS MADE

CHIEF ENGINEER

DATE .....

Time	Barometer Reading	Ther. R'd'g	Average Barometer / Thermometer / Weather
1:00 A. M.			
2:00 "			
3:00 "			
4:00 "			
5:00 "			
6:00 "			
7:00 "			
8:00 "			
9:00 "			
10:00 "			
11:00 "			
12:00 Noon			
1:00 P. M.			
2:00 "			

SMALL CENTRAL-STATION RECORD FORMS

Editorials

Coal Operators Indicted

About three weeks ago we began the making of a table giving the coal cost in cents per horsepower-hour and per kilowatt-hour for various consumption rates and prices per ton. We carried the latter to $10 per ton; but a little over two weeks later coal of the Pocahontas and New River grades sold alongside at Providence and Boston at $13 to $15 per ton. So our table to be of maximum value had to carry its price per ton to $15. This affords a most realistic impression of the coal situation as it confronts steam users.

One naturally wants to know the why of this steady increase in coal prices—if it is due to illegal combinations. This matter is now before the Federal District Court, New York City, and therefore judgment must await the court's findings. On Tuesday, March 6, the Federal Grand Jury returned two indictments against sixty-four coal operators and one hundred and eight coal companies for engaging in a combination in violation of the Sherman Anti-Trust Law. These operators handle Pocahontas and New River coals.

The Government charges that these operators sell about twenty-two million tons of coal per annum which, before the alleged combination, would have sold for $27,500,000 and at a fair profit. With the contract price at $3 per ton, the companies would receive $66,000,000 for this much coal. It is alleged that fifty-five operators met at the Waldorf-Astoria in January and agreed to raise the contract price from $1.25 per ton to $3 per ton at the mine after April 1 next.

There seems little room for doubt that bituminous-coal prices are and have long been too high. New England is and has been these last two years exceedingly busy. Coal is vitally necessary to the filling of the many contracts, and Pocahontas and New River coals are the ones most widely used in this section. What makes the action of the operators all the more detestable, if they are guilty of illegal and greedy conduct, is that so great is the demand for coal that consumers, while bitterly denouncing the coal men for the extraordinary prices asked, are actually pleading with them to accept contract business at the high prices. Not before in the history of the coal trade has there been such a sustained period of extraordinarily high prices. If this is because of illegal combinations, those guilty should pay in full the penalty.

Among some of the smaller consumers of New England, particularly Boston, there is much hope held out because of reports in the daily press that "millions of tons of anthracite (culm) which have been for twenty years lying in neglected heaps in Pennsylvania are to be made available for use presently." Let the consumer abandon hope. The culm piles of Pennsylvania have for years been yielding big profits, and few are left even now.

Of course the coal operators are not without reasons for complaint and price increases. Labor conditions at the mines are serious. Operators have been forced to advance wages, shorten hours, advance credit at company stores and even sell commodities at cost to hold the labor from seeking and accepting the attractive offers in other industries.

Transportation facilities are in a veritable upheaval. Only recently a freight rate, Hampton Roads to Boston, of $4 per ton was refused. So acute is the shortage of bottoms that marine rates are becoming unbearable. The rail situation is well known to have lately reached a state of collapse. The coöperative efforts of the roads to relieve this situation, begun a few weeks ago, is slowly giving good results.

It is reported that railroads have in some instances withheld cars to coal shippers, or advised that only cars for coal for railroad use were available. The roads have held out, and in some cases are reported to have obtained coal at the old low prices by what amounts to coercion of the operators.

In a time of coal shortage such as this, with not only small consumers unable to get fuel, but with many comparatively large power stations forced to reduce their output, with railway service crippled in some instances, mills forced to suspend operation in some departments, and with the many other regrettable conditions coal shortage produces, one's thoughts turn to the question of the plant's coal storage capacity. Because the present conditions are very abnormal too great an investment for this purpose is not warranted; but that the average plant should increase its coal storage capacity is certain.

How Do You Clean Your Condenser?

Since the advent of the turbine has made important the maintaining of a high vacuum, increased attention to the condition of the condensing surface has become necessary. Engineers, accustomed to reciprocating-engine conditions where a vacuum of twenty-six inches was all that was required, often do not appreciate the fact that to maintain the high vacuum now desirable the condenser and its connections must not only be more than ordinarily tight, but the cooling surfaces must be kept free from anything that will impede the transfer of heat. Many continue to think that the condenser needs cleaning only once a year or once in six months and that squirting water over the ends of the tubes will do. No practicable amount of cooling surface will continue to condense the steam quickly and thoroughly enough unless that surface is cleaned—actually cleaned—at reasonable intervals.

Power would welcome discussion from its readers regarding their experience and practice in this respect. How often do you clean your condenser? What process do you use? How long does it take? What is the character of the circulating water and how much and what kind of deposit do you find? How much difference is there in the hotwell temperature and the vacuum obtained before and after cleaning? We are sure that a comparison of usages, methods and results obtained in this increasingly important item of power-plant operation will be mutually helpful and interesting.

Engineering Education as a Feature of a Foreign-Trade Policy

In this country there is a great awakening to the important part that the engineer has played and must exercise in our economic and industrial development; and it is realized that only as a people advance in the science of engineering is there material progress. Therefore, it would seem that a policy looking toward foreign trade with a people lacking these advance guards of progress would be incomplete unless provisions were made to educate them to an appreciation of engineering methods.

In a recent issue of the *Electrical Review* of London, Prof. Middleton Smith describes the work that has been accomplished by the University of Hong Kong. This university was founded in 1912 to extend British trade in China and to educate young Chinese to use British machinery. An appeal for equipment and apparatus to fit out the laboratories of this school of engineering was made on patriotic grounds to English engineering firms. Some two hundred firms contributed machinery and accessories to the value of approximately $60,000, and the steamship companies, appreciating the worthiness of the undertaking, carried the equipment to the Far East free of charge. Thus, the first engineering school in China was opened with 37 students, of whom 12 graduated in December, 1916, with the degree of B. S. At the present time over 100 engineering undergraduates are enrolled.

China's appreciation of what this school means to her is shown by the enthusiasm and practical assistance of her leading subjects. At the graduation the ceremonial hall was crowded with leading Chinese from all over the republic. Even the president sent a message from Pekin, and he has founded scholarships, while some of the provincial governments send students and maintain them by public funds.

The extension of educational facilities is work of which any nation may well feel proud. The United States has been doing more for China in this respect than is probably generally realized. According to the settlement of the Boxer indemnity between this country and China, the latter sends a number of young Chinese to American universities each year. Facilities are also afforded such of these students as elect engineering to obtain practical experience by spending a year or two in large industrial establishments. This policy has had a far-reaching effect in transferring the engineering spirit of the great republic of the West to that of the East, as is attested by the part that many of the young graduates are taking in the development of their own country.

The awakening of China to her necessities seems to be aptly summed up in the words of Professor Smith: "The Europeans in this part of the world often complain that there is little evidence of change of the customs in China. It is true that the surface of the country is barely scratched. But there has been a real alteration in the outlook of the more influential Chinese. They all appreciate the value of what they call Western science. They are essentially men of commerce; and they are beginning to demand machinery, because they believe it will enable them to make money. At present they are thinking about three distinct branches of engineering work. They want to see a great extension of railways; they wish to have electric lights; and they are very keen upon exploiting the mines of their own country."

But before China can come into what is truly her own by having these resources beneficially developed, it will be necessary for her to be able to educate, or at least partly educate her own engineers. Here is opportunity for America to establish at least one engineering center of education within the borders of China. Bringing young Chinese to the United States for engineering education is highly commendable, but there can be no disputing the fact that establishing such a great economic force within her borders is better and will react to this country's advantage in trade connections.

⁂

The Metric System

That it would be conducive to efficiency to have a single world-wide system of standard units of weights and measures cannot be disputed. The formulation of the metric system and its proffer for general adoption are attempts in this direction. There are societies organized for its promulgation and societies to resist its imposition. Just at present the air is full of it, and the editor's desk is piled with arguments upon both sides.

Whatever may be the relative merits of the metric and duodecimal systems, either of them in universal use would be better than both, and we have no sympathy with the assumption that no movement in the direction of a universal standard is practicable. It is a fact that the change will cause inconvenience and expense, but the sooner it can be brought about the less inconvenience and expense will be caused. Every day adds to the tables and formulas, the drawings and patterns, the literature and finished parts which will have to be discarded or altered if either one of the other systems wins. Moreover, this country is emerging upon a new era in foreign trade. The exports to South America have nearly trebled in the past two years and the end of the war is likely to see a heavy demand for American machinery in Europe. Most of these countries already have the metric system, and a common standard would go far toward holding this business.

At the same time the opponents of any sudden and radical change have weighty reasons to present and are entitled to a patient hearing and to careful consideration. We should like to see the movement in the direction of a single universal standard progress as fast as possible, with due regard to the equation of the possible present hardship with the growing expense and difficulty which will be occasioned by delay.

⁂

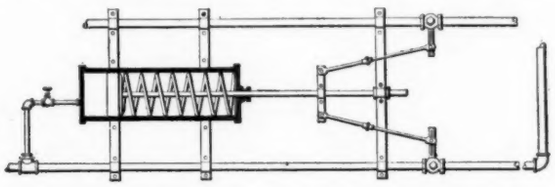
Surely, no body of men has thrown itself more thoroughly and broadly into the campaigns of preparedness than engineers of all classes. This is likely so because no other profession realizes more fully the magnitude of the task in a crisis or appreciates more fully the hazards of delay. The engineering schools and colleges are to be commended especially. Some have for months been engaged in determining by correspondence with members of the alumni just what kind of work each is best fitted to do. The information, names and addresses have been filed, and in the event of need these men may be made available with the greatest dispatch. Prominent among the institutions doing this are the Massachusetts Institute of Technology, Yale, Princeton, Stevens Institute and others. Those not doing so should lose no time in making such a list available. It is their duty.

Correspondence

Regulator for Oil Burner

The illustration shows a regulator for oil burners that was rejected by the Patent Office about ten years ago, on account of previous patents. I would like to ask if any readers of *Power* have seen or used such a device.

The regulator consists of a cylinder fitted with a piston and a coil spring, as shown, with the piston rod connected to the steam and oil supply to the burner. Steam pressure is admitted to the cylinder through a small pipe so that when the pressure increases the spring will be compressed and as the piston moves forward the valves on both steam and oil supply pipes are partly closed, reducing the rate of steaming; but as soon as the boiler pressure reduces slightly, the piston is forced backward by the spring, thereby opening the valves proportionately. Adjustment is provided to regulate the relative rate of action of the valves.



AUTOMATIC REGULATOR FOR OIL BURNERS

GORDON HOLLOWAY.

Grand Canyon, Ariz.

Furnishing Extra Steam for Heating

Some time ago the owners of a plant furnishing current for street-railway and lighting purposes decided to go into the steam-heating business also. The plant consisted of three alternating-current turbine units running condensing, one rotary converter for the railway load and one 500-hp. four-valve automatic engine direct-connected to a direct-current generator, which was used in case anything happened to the alternating-current end of the plant. They planned to shut the rotary converter down and run the engine during the winter months while the heat was on.

Experiments were first tried with live steam running through a reducing valve, but it was decided that it was cheaper and better to use exhaust than live steam for heating purposes. As the heating business grew, the exhaust from the engine was not sufficient to keep the pressure in the heating mains up to the required standard because the railroad load was uncertain, so it was then found necessary to add live steam to the engine exhaust. After much thought it was decided to use the rotary converter as a d.c.-a.c. motor-generator set, the alternating current being stepped up and fed in on the switchboard busses. To do this, the only change necessary was to reverse the series-field winding on the rotary with a double-throw two-pole switch fastened on the frame of the rotary, so it could be changed back at a minute's notice at any time. It was also necessary to keep the direct-current voltage on the steam unit a trifle higher than on the rotary so as to keep it from reversing itself, although it could do no more harm than to knock out the breaker.

Making this change, it was found, served another very important purpose. It caused the engine to run under a full load at all times, furnishing enough exhaust steam for heating purposes during the winter months, and it also served to ease up on the alternating-current turbines and brought down the peak load on these machines considerably. This method of operation has given satisfactory and economical results.

Coatesville, Penn. PAUL B. PRUTZMAN.

Higher Steam Pressures—Further Comments

With regard to the very interesting article in *Power*, Feb. 13, on the new Buffalo power plant, and the symposium in the same issue on the advisability of using considerably higher steam pressures and temperatures to increase the economy of power-plant operation, it might perhaps be of interest to open the discussion on a solution of the problem, as far as the prime mover is concerned, which has not been considered by any of Mr. Bromley's correspondents.

The solution I am referring to is not new, and has been successfully tried out, but with a different object in view. It is the well-known combination of a reciprocating engine for the higher range of pressures, with a turbine for the lower range. I wonder whether the late Henry G. Stott, who applied this principle with such remarkable success in the Fifty-Ninth Street Station, Interborough Rapid Transit Co., of New York, did not seriously consider its possibilities when he planned the Buffalo plant now attracting such wide attention.

It is true that the application of this mixed process in the Interborough station was brought about by different considerations, and also that the steam pressure dealt with there had nothing prohibitive as regards the use of straight turbines. Nevertheless, the fact stands that these combined units showed a superiority in efficiency of about 13 per cent. over the best turbine installations of that time, proving beyond doubt that the principle involved is correct and sound. It has been conceded that the first stages, even of the latest large-sized types, have an efficiency of less than 50 per cent., the total high efficiency of the unit being entirely due to the low-pressure end, and in particular to the high efficiency of the very last stages. Since the low efficiency of the high-pressure stages is due mostly to wheel friction and leakage and since both grow with the density of the steam, it is obvious that conditions will grow worse and worse with increasing initial steam pressure.

On the other hand, the use of very high pressure and superheat in a reciprocating engine does not involve any seriously increased losses. Experience has already sanctioned the use of pressures and temperatures in line with

the values here under discussion, temperatures of 500 to 700 deg. having become the best standard European practice for certain types of engines.

Everything seems to point to the reciprocating engine as the natural high-pressure end of a unit with wide pressure range. As to the objection of mechanical complication with the combined engine-turbine unit, it should be remembered that the necessary dividing of the straight turbine unit in two, into a high-pressure and a low-pressure side, is a constructive complication. Furthermore, the design of a high-pressure turbine working at such extreme pressures and temperatures would be a problem offering its own peculiar difficulties, among which we need only mention the question of stresses, the warping and working of the different parts, the construction of tight packing boxes, etc. A combined engine-turbine unit would be mechanically more complicated, but it would certainly recommend itself for its better thermal efficiency.

A working process, similar to the one outlined, has been proposed and patented for a combination of a Diesel engine with a gas turbine, avoiding thereby the objectionable high temperatures which have so far been the main obstacle to the successful operation of internal-combustion turbines. The experience gained with Diesel engines would, no doubt, be valuable in designing a steam engine of large power to take care of, say, 600 lb. pressure at 600 to 700 deg. temperature. Many features of the Diesel could be borrowed—in particular, the open cylinder and piston.

Engine Geared to Turbine Shaft

Another point worth mentioning is that the experience gained of late with large high-speed gears would probably lead to gearing the engine shaft directly to the turbine shaft, thereby avoiding the use of two generators and enabling the design of an attractively compact machine.

A few figures may illustrate roughly what might be expected in a specific case, say of a 20,000-hp. unit, which seems to be now an average size for larger power stations. Assuming an initial pressure of 600 lb. and a temperature of 650 deg. F., an expansion down to 175 lb. in the engine and from there to 2 in. absolute pressure in the turbine, the available heat drop in the engine would be approximately one-fourth of the total. If we assume the conservative value of 75 per cent. for the Rankine-cycle efficiency ratio of the engine, and also, that in a high-pressure turbine utilizing the same heat drop, this efficiency would certainly not be more than 50 per cent., then the total efficiency of the mixed unit would be $\frac{1}{4}(75 - 50) = 6\frac{1}{4}$ per cent. better than that of a straight turbine of the compound type. If the latter had, for instance, an efficiency of $72\frac{1}{2}$ per cent. compared with the Rankine cycle, the efficiency of the combined unit could be raised $6\frac{1}{4}$ per cent. above this value and would be $1.0625 \times 72.5 = 77.5$ per cent., as a conservative estimate.

The power developed in the engine would approximate 5000 hp., which could be divided in, say, four single-acting cylinders of perhaps 24 in. diameter and 36-in. stroke, running at 120 r.p.m. A gear ratio of $1 : 12\frac{1}{2}$ would bring this speed up to 1500 r.p.m., if this be chosen for the turbine.

Gears of this size have been successfully applied to marine turbines, and no special difficulty should be expected from that source. Likewise a turbine of 15,000 hp. with 175 lb. inlet pressure would be nothing more than a common standard type as far as present practice goes. New and special developments would therefore only be required in designing the high-pressure engine, although no particular difficulties seem to present themselves.

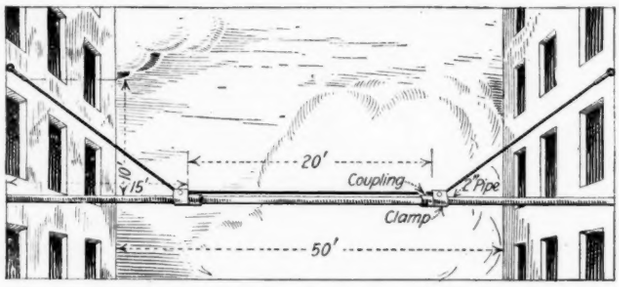
The question whether the economical advantage would outweigh the complications in design and operation of a combined unit, as here mentioned, would have to be answered by power-plant operating authorities, the foregoing remarks purporting merely to invite additional discussion of the subject, which is worth further investigation.

Paul Hoffman.

Phillipsburg, N. J.

A Simple Pipe-Line Support

A 2-in. water supply line became necessary between the upper floors of two buildings located on opposite sides of a passageway about 50 ft. wide. Supporting the pipe line was accomplished in a simple and inexpensive



PIPE LINE SUPPORT BETWEEN BUILDINGS

manner, as shown in the illustration. Two clamps were placed around the pipe near couplings about 15 ft. from each building and through them a stranded galvanized wire cable which was fastened to eye-bolts through the wall about 10 ft. above the pipe line and drawn up taut to support the line.

M. A. Saller.

Philadelphia, Penn.

A Curious Fuse Failure

In a large packing house a number of three-phase induction motors were used for operating an elevator, conveyors, brine pumps and similar applications. In the middle of the afternoon the elevator suddenly began to work queerly, at the same time making a peculiar noise. It started all right, although slowly, in one direction, but not in the other. The controller was examined, but nothing was found wrong. Tests at the service showed that three-phase power was being supplied. As the electrician was convinced that the trouble was in the elevator motor, it was taken out for repairs.

Next morning when the packing plant was started up, it was found that the conveyors, etc., all ran in the wrong direction. One pair of leads were reversed on each motor to make them run in the right direction, thinking that the conductors had been changed outside by a lineman. About this time it was noticed that smoke was coming out of a motor operating a centrifugal pump used for circulating brine. It was found that this motor was running in the wrong direction and instead of circulating the brine was merely churning some of it.

Examination of the cutout for the circuit supplying the brine-pump motor, also those other motors that had reversed rotation, showed that one of the three fuses had blown. This fuse was replaced, and all the motors that had their leads reversed to make them run in the right direction now ran the wrong way. The brine motor had to be cut out, as it was badly charred.

The blown fuse in the branch circuit carrying a number of the motors was the cause of the trouble, and the explanation is as follows: When the fuse in one phase blew, all motors on the circuit continued to operate single-phase instead of three-phase. The only motor that ran continuously was that driving the centrifugal pump, all the others starting and stopping at frequent intervals. When the circulating-pump motor was the only one running, it was unable to develop enough torque when running single-phase to operate the pump and circulate the brine. The brine backed up into the pump and reversed the rotation of the motor, which continued to run as a single-phase machine. This motor generated voltage in the phase that was open, owing to the blown fuse, and thus permitted motors on the same branch circuit to start, provided one was started at a time. When an attempt was made to start two or more at once, it was impossible to do so because of the limitations of the motor, connected to the circulating pump to act as a phase converter. The reason for the winding of this motor heating to such an extent that the insulation charred was, of course, due to the heavy current taken by the active phase, which current was transformed fo the other phase to run the motors on the same circuit in addition to supplying the torque required by the motor.

This incident may happen elsewhere, and the reversal in direction of elevator and conveyors might cause a serious accident. In the present instance an actual expense of about $500 was incurred due to a fuse blowing and to making a hasty conclusion which would not have been reached had the branch-circuit voltage between phases been measured.

M. A. WALKER.

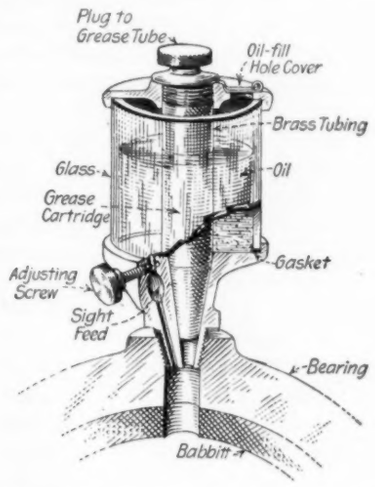
Chicago, Ill.

Combination Grease and Oil Cup

I have often wondered why a combination grease and oil cup, similar to that shown herewith, has not been placed on the market, in which oil is ordinarily fed as the lubricant and the grease retained for an emergency. The object of such a device would be to prevent the overheating of a bearing in the event of the oil passages becoming clogged or failure to start the oil-cup feed or neglect in replenishing the oil supply. It is expected that the grease would be compounded to assume a liquid state at any desired temperature, depending upon the service. The space between the glass body of the oil reservoir and the grease cartridge tube would act as a dead-air space, thereby reducing the heat loss at this point and make the temperature of the bearing more effective in reducing the grease.

This device would be especially adapted for installation on machinery in inaccessible places; that could be stopped only at intervals; where owing to its movement it would not be possible to ascertain the absence of oil in the reservoir; where stoppage other than at agreed times would endanger lives and property; where unskilled labor is used; where rotative speeds are high; and where failure to lubricate would entail costly repairs and monetary loss due to curtailment of production.

This type of cup could be installed on mine fans, coal-handling, grinding or other machinery, where dust or grit was present, in dark places or where it was hazardous



COMBINATION GREASE AND OIL CUP

to go while the machinery was in motion, and in fact on all machinery depending upon intermittent or hand lubrication.

I believe that such a device would prove an additional safeguard, reduce the liability of hot bearings and shutdowns to a minimum and be an assurance of constant service.

THOMAS R. TARN.

Pittsburgh, Penn.

Pointers on Boiler Feed-Water Treatment

In reply to J. P. Colton's inquiry in the issue of Feb. 13, page 232, I would point out that tri-sodium phosphate is more expensive per pound than lime or soda ash, cannot take the place of lime and is only one-third as effective per pound as soda ash. My experience is that it is objectionable to feed tri-sodium phosphate, and many other chemicals for that matter, directly into the boiler, as this results in the precipitation of the scale-forming solids in the boiler as sludge, which may lodge on the heating surfaces in such a way as to cause overheating of plates, and also interferes with high steaming rates and increases the tendency to foam or prime. Another objection to the ordinary method of feeding tri-sodium phosphate and other chemicals directly to the boiler is that suitable accurate proportioning means is not employed, resulting in overtreatment or undertreatment, the former leading to waste of chemical and the latter to the formation of scale. A better plan is to treat the water properly, in an independent outside water softener, using lime and soda ash, which, at present prices, are by all odds the cheapest reagents. This will protect the boilers from scale which cannot be washed out and, if the proper size and type of softener is used, will almost entirely eliminate sludge from the boiler. By heating the water before adding the reagents, as in the combined heaters and softeners or hot-process softeners now on the market, air and other gases can be driven

out of solution and scale-forming solids as low as one-half, one or two grains per gallon secured without recourse to the expense and trouble of filters and without feeding any appreciable excess of chemical reagents, due to the more perfect and complete reactions obtained under the influence of heat.

The deaëration of boiler-feed water, as by spraying it through a steam bath, is a most beneficial measure in preventing corrosion of boilers, economizers and piping. Water that has been deaërated and rendered slightly alkaline by soda ash will not attack the interior of the boiler. I would not agree with the practice suggested by Mr. Morlock in the issue of Jan. 6, page 189—that is, charging a large amount of soda ash into the boiler after each washing—because the temporary excess is apt to cause foaming and priming, if boilers are driven at all hard. This is not due so much to the soda ash alone as to the presence of lime and magnesia sludge precipitated by it. A much better way is to install an improved softener and feed the soda ash as required to transform the scale-forming and corrosive substances. This should be done strictly in accordance with the amount of water used, preferably by an automatic and reliable chemical feeder forming part of the softener apparatus. WILLIAM B. CAMPBELL.

Philadelphia, Penn.

There is in the issue of Feb. 13, page 232, a request for information as to the use of tri-sodium phosphate for boiler feed-water treatment.

I am at present trying out a compound that I mix myself from tri-sodium and borax in the proportion of 2½ lb. of the former to 1 lb. of the latter. This compound is dissolved in hot water and fed to boilers by any handy means every 12 hours. I have a little pump rigged up specially for this work, and our boilers are in operation 24 hours per day. In testing, I first thoroughly blow down the column and then take a sample of column water. This should be done just before the compound is fed, so as to show if the last "dose" of compound is holding over until the boiler gets another supply. I make up my own testing material in the form of a solution of powdered turmeric water. This yellow solution turns a bright reddish brown when in contact with water containing tri-sodium. One-fourth of an ordinary drinking glass of the column water is sufficient, and a teaspoonful of the turmeric solution.

In starting I fed 5 lb. at a time, but after a few days' run I found the color so strongly red that I cut the amount in half and still find that it shows a good bright color when tested and shall probably cut the supply still more.

If the foregoing helps any others who are having scale troubles, I shall be pleased to have been of some little service in telling how I am using tri-sodium and keeping track of it in the boiler. R. G. SIMONTON.

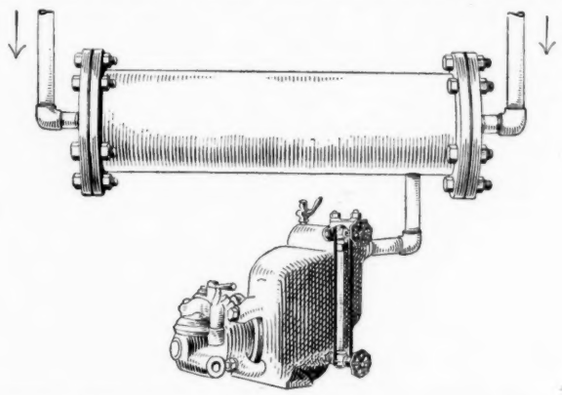
Lambertville, N. J.

I have had an experience similar to that of George Smith and J. P. Colton with hard feed water and had no end of trouble with scale until the firm installed a water softening plant, and now our boilers are shedding the old scale by the bushel. This softening plant is not expensive to operate and requires no great amount of work or skill in operation. It surely does work wonders on the scale in the boilers. We have a liquid soap used in testing for hardness, and it takes 28 drops of soap to 40 c.c. of raw water to make the amount of lather that 3 drops will make after softening.

Cincinnati, Ohio. EDGAR ALTMAN.

Receiver on Drip Line to Trap

The drains from the steam lines to two small engines were connected to a 1-in. high-pressure steam trap and worked satisfactorily most of the time, but occasionally, when slugs of water came over with the steam, the trap



RECEIVER TO TAKE CARE OF SLUGS OF WATER

could not handle it and it backed up in the line. It was decided to put in a receiver of sufficient capacity to take care of the slugs until the trap could handle the water, and it was made and connected up as shown. The trap now takes care of all the water that comes its way.

Philadelphia, Penn. M. A. SALLER.

A Bell-Ringing Transformer Made from a Spark Coil

In the Feb. 6 issue G. C. Long criticizes my bell-ringing transformer as described in the issue of Oct. 31. In this criticism he refers to the primary winding as being the winding on the core, which is right provided it is to be used as a jump-spark coil. I referred to the device as a transformer, therefore called the fine wire the primary connected to the source of supply. I can only estimate the turns in the primary and secondary windings, but as now connected there are some 20,000 turns in the primary and 360 in the secondary. The primary is of No. 36 B. & S. silk-covered wire and the secondary, No. 18 double-cotton covered. The ratio is close to 57:1, which at a voltage of 114 on the primary would give 2 volts on the secondary, not considering the losses in the transformer.

I made no count of the turns removed from the primary, but made tests until I got the proper voltage to ring a bell. However, about one-third of the winding was removed. At the present time the transformer is operating on an electrical alarm clock and works very successfully. L. L. NEWCOMB.

Redondo, Calif.

Antifriction Metal for High-Speed Machinery may be made of 17 parts zinc, 1 part copper, 1½ parts antimony. Melt the copper first in a crucible, keeping it covered while melting, then add the antimony, let it cool a little and add the zinc. This metal does not pour well for lining cast-iron boxes, but may be cast for making solid boxes.

A Dangerous Boiler-Room Practice

A boiler-room practice I have seen in some large manufacturing plants of the South does not seem good; namely, that of permitting boilers to float on the line for lengthy periods when they are not being fired or even kept hot by a banked fire. The idea in doing this is to always have the boilers hot, ready to put into service.

I am of the opinion that the practice should be discouraged as dangerous and uneconomical. Very often the boilers are permitted to fill with water by condensation or through leaky feed valves until there is a constant stream of hot water being fed from the feed pump through the boiler directly into the steam header. And it does not take long to waste a ton of coal under these conditions, to say nothing of the danger from water in the piping and machinery.

T. JEFF CRAVEN.

Hebardsville, Ga.

Taking Temporary Charge of a Plant

It sometimes falls to an engineer to be placed temporarily in charge of a power plant pending the appointment and arrival of a successor to a former chief. If the first assistant engineer is asked to take up this work with the understanding that an outsider will supersede him sooner or later, the feelings of the temporary appointee may be understood and need not be set forth here, assuming that he is competent to take up his former superior's duties. The practical problem is how to conduct the affairs of the plant so as to get the best possible results during the interim.

Personal opinions have no place in dictating the kind of service to be rendered. The right way to look at a temporary elevation in rank is to regard it as a real opportunity to show forth one's best professional attainments. If these do not lead to an appointment as permanent chief—and they may not, in many cases through no fault of the incumbent—there is time enough then to consider whether the limit placed on advancement is such as to warrant looking for another post. Even a newly appointed and "arrived" permanent chief may sometimes fail to suit the local situation after a few weeks' or months' service, and stranger things have happened than for the assistant who for a time was acting chief to be once more asked to take up the executive job, this time to hold it at full payroll rating and with no thought of replacement. A young and ardent engineer may be inclined to quit his job before circumstances really warrant, and a good deal of careful analysis always pays, before taking such a step from a plant where the work is interesting, the experience valuable, the concern growing and the opportunities good for contact with others in the profession.

Local conditions must determine the policy of such an assistant. Certainly, everything should be handled in a way to secure the full coöperation of the associates of the chief pro tem. It is a mistake to let matters drift along, through lack of interest resulting from the belief that little credit will be given for good work done. It may be that under the former administration the assistant chief saw opportunities for improvements which he could not carry into effect because his former superior did not believe in them. Such of these improvements as can be effected economically during his temporary administration may well be instituted, and a tactful presentation of these possibilities to the management is a good thing for both parties to the conference.

During his period of entire responsibility for the station service, the opportunities before the temporary chief may be greater than ever before in his career. He may get a chance to study certain combinations of equipment and the performance of certain apparatus under varied conditions that will open new fields of experience and perhaps help to qualify him in certain lines of work.

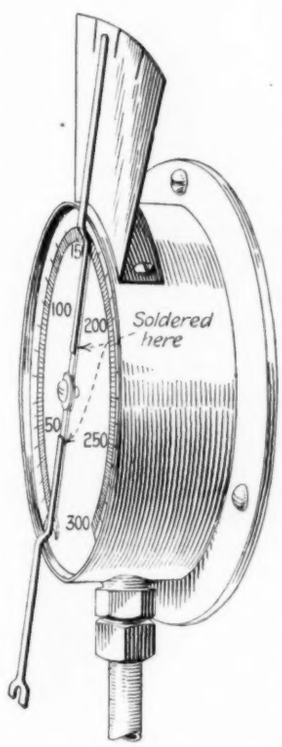
If there is any time when it pays to strike while the iron is hot, it is when a plant is so placed in one's charge, where all the conditions of production and of cost can be gone into at length. Preparatory to such an assignment should go the study of the plant's general-development problem, so that the acting chief will at least have sound ideas of the station evolution so as not to be "stumped" for thoroughly first-class recommendations for large and comprehensive improvements in case of necessity or desirability.

H. S. KNOWLTON.

Cambridge, Mass.

Wide Graduations on Steam Gage

The illustration shows a steam-gage kink that is found useful in maintaining a uniform boiler pressure. With the average steam gage it is difficult at times to tell whether the steam pressure is increasing or decreasing slightly, owing partly to the lost motion, or backlash, in the mechanism and partly to the small movement of the pointer for considerable change in pressure; and if the gage is mounted high or at a distance, it is still more difficult to detect a slight change in pressure. Our new recording gage showed a big variation in pressure when the gage on the boiler had shown very little. The boiler was new, clean, lightly loaded and fired with gas, so with careful attention, such as it was getting, there was no good reason for a great variation in pressure. To enable the boiler attendant to detect the slightest change in pressure, the gage was arranged as shown, and by prompt adjustment of the gas at the burners an excellent chart was produced on the recording gage. An old gage was secured and mounted at the side of the regular gage on the boiler front. The glass was removed and the pointer extended by soldering two pieces of aluminum link fuses, such as are used in out-of-door cutout blocks, on the ends of the regular hand of the gage. The object in lengthening both ends of the pointer was to maintain a good balance. A strip of tin was cut out and fastened to the gage and faced with a piece of white paper



EXTENSION ON GAGE HAND

stuck on with shellac. This was marked as shown, the high mark indicating the point at which the safety valve lifted, the middle mark the desired pressure and the lower mark the lowest permissible pressure.

Mansfield, Ohio. J. C. BRAND.

Testing Feed Water for Salt

In the issue of Feb. 13, page 230, Mr. Seaver says that my feed-water testing outfit (described in the issue of Oct. 24, 1916, page 602) is open to objection "for the batteries are not of sufficient strength to close the circuit and to give a sufficiently large reading range" and therefore improves my method by using 600 volts. Readers of *Power* might at first get the wrong impression that such high voltage (600 volts) is necessary for testing the salinity of water.

My feed-water testing outfits have been in everyday use (twice daily) for more than five months on two big railroad power plants in New York City; each outfit is supplied with two dry cells, and they give readings that check up closely with carefully made chemical tests, with the batteries still in good condition, and I expect them to last at least five months longer without renewing. The simplicity, accuracy and small cost of my outfit with practically no operating expense will be appreciated. H. WYGOD.

New York City.

The Gasoline Problem

I would like to call attention to some points in the editorial on page 187, in the issue of Feb. 6, entitled "What Is Gasoline?" In the first paragraph it is said that "a few years ago the sale of motor fluid below 70 deg. Baumé as gasoline would have been regarded as a transaction warranting a remonstrance on the part of the purchaser and an explanation on the part of the vender. Today stock having a gravity of 60 deg. Baumé is considered excellent, . . ."

The inference appears to be that specific gravity or degrees Baumé can still be considered an indication of gasoline quality. A careful investigation by Government bureaus and other disinterested observers has brought out the fact that specific gravity is of little or no value as a guide in selecting a motor fuel and that any relation of volatility to gravity which possibly exists, applies only to gasoline from a given oil field and has no general significance.

It may be of interest in connection with the closing paragraph of the editorial to state that a recent examination of the output of several of the larger gasoline producers, as sampled at service stations where no opportunity for adulteration at the hands of a dishonest retailer had been afforded, showed a noticeable uniformity as regards distillation range. I agree that in the interest of standardization it is desirable that motor fuel of one or more grades be put out labeled in each case with its distillation range. I do not see, however, that this will in any way serve as a "yardstick" for the purchaser. A yardstick is an instrument that can be used by anyone of reasonable intelligence, but the average individual cannot determine the distillation range of a highly volatile oil. While the labeling suggested by the committee referred to is undoubtedly desirable and will accomplish some good ends, legislation is not a universal panacea for all evils, even including those arising from economic causes.

The underlying problem in the whole situation is economic since the enormous increase in the use of the automobile has increased the demand for gasoline manyfold without there being a corresponding increase in the production of crude oil. By far the largest product in distilling crude oil is kerosene, the demand for which has rapidly fallen off so that the present price of gasoline is about three times that of kerosene.

The reasonable method of attacking the automobile fuel problem would appear to be a getting together of oil producers and automobile manufacturers with the aim of producing an engine that will show a satisfactory performance on that fuel which can be most economically produced. Such a fuel must of necessity include some of the heavier oils, as kerosene, which may now almost be considered as byproducts of gasoline manufacture.

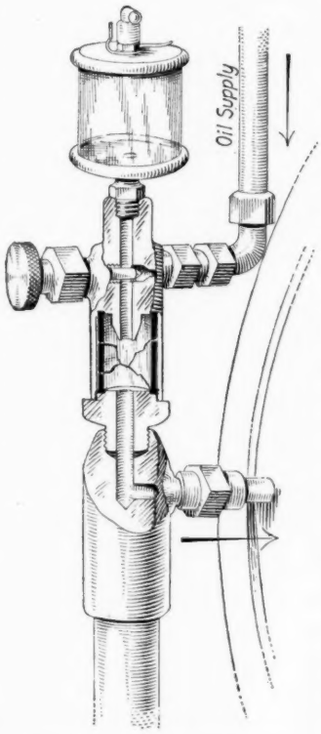
More agitation along these lines and less in the direction of additional legislation would appear to be the rational mode of attacking a problem that is rapidly becoming more serious. H. S. VASSAR,

Laboratory Engineer, Public Service Electric Co.

Newark, N. J.

What Caused the Overflow?

On an automatic engine oiling system one of the sight glasses was broken. After the pieces of glass were cleared away, the oil overflowed. The discharge hole was drilled and tapped and a larger pipe put in to carry away the oil, and although this improved conditions, the oil would still overflow at the normal rate of feed and it had to be cut down. When a new glass was put in, it was impossible to cause an overflow even with the regulating valve wide open. The figure shows the style of feed fixture. What caused the oil to overflow when the glass was broken? and why did the overflow cease when the glass was renewed? The crank pin is 8 in. long by 8 in. diameter with a hole drilled from the outside center lengthwise of the pin to a hole drilled at right angles to the center of the bearing surface. Not only was the pipe connection to the crank pin enlarged, but the passages below the glass were also drilled out larger. The reason the oil overflowed is that with the glass broken the drops of oil carried slugs of air into the discharge pipe and the air globules prevented the oil from flowing to the pin. When the glass is in position a partial vacuum is formed in it and the oil is free to flow to the pin without obstruction.



OIL-FEEDING FIXTURE

Inquiries of General Interest

Balance of Pressure in Water Leg of Boiler—As the outside shell of the water leg of a vertical fire-tube boiler is larger in diameter and more area is presented to pressure than the total pressure on the firebox sheet, how is the balance of pressure resisted? F. M.

Any excess of pressure acting on the exterior shell, that is not taken up radially and transmitted by the stay-bolts to the firebox sheet, must be resisted as a hoop stress in the outside shell.

Heating Feed Water at Expense of Back Pressure—Would any benefit to economy be obtained by connecting the exhaust of feed pumps to the exhaust of a noncondensing engine in obtaining higher temperature of the feed water in a closed feed-water heater? B. G.

A higher temperature of feed water could be obtained only at the expense of higher back pressure of the exhaust both of the engine and of the feed pumps, and unless all the exhaust is utilized, the increase of back pressure would be detrimental to economy.

Static Discharge Using Steam Flue Blower—When cleaning boiler tubes with a flue blower, what causes a blue spark when the blower comes in contact with the flues? W. G. W.

Frictional electricity is developed by the discharge of steam through the blower, and while the blower is supported by a rubber hose or other poor conductor of electricity without grounding the electricity so generated, it is gathered on the surface of the blower as static electricity that is discharged with a spark when a ground connection is made by contact of the blower with the boiler.

Formula for Capacity of Pump—What is the formula for the capacity of a double-acting piston pump? C. H. B.

The theoretical displacement of a pump having a single double-acting piston, neglecting the piston rod and slippage, is given by the formula,

Displacement in U. S. gallons per minute = area of plunger in square inches × piston speed in feet per minute × 12 ÷ 231

or where G = displacement of one double-acting plunger in U. S. gallons per minute, d = diameter of plunger in inches, and P = piston speed per minute, $G = 0.0408d^2P$. For a duplex double-acting pump multiply by 2. When the actual capacity is to be calculated, the displacement of piston rods and slippage are to be deducted.

Use of Feed Pump for Obtaining Test Pressure—What is the advantage of using a clamp or gag on a pop safety valve when making a cold-water test of a boiler, and will it injure the regular boiler-feed pump for pumping up the test pressure? W. C.

Hydrostatic or cold-water pressure tests usually are made at a pressure 50 per cent. higher than the highest allowable working pressure for the boiler, so that if the pop valve has been set for the highest working pressure the test pressure could not be attained without holding the valve to its seat. No injury should be done to the regular feed pump for obtaining the test pressure, but the use of a steam or power pump is not advisable as the test pressure cannot be approached so gradually as by use of a hand pump and might result in damaging the boiler from application of excessive pressure.

Power Required for Loads at Different Power Factors—Will an engine have to develop more power when driving an alternator supplying a 1000-kw. load at 0.85 power factor than 1000 kw. at unity power factor? W. E. M.

More power will be required at 0.85 power factor than at unity. Although the output of the machine is the same in either case, the current at 0.85 power factor will be approximately 17.5 per cent. greater than at unity power factor. This will cause an increase of about 39 per cent. in the copper losses; that is, if the copper losses at unity power factor are 20 kw., at 0.85 power factor they will be 20 × 1.39 = 27.8 kw., an increase of 7.8 kw., which will have to be supplied by the engine. The field current will also have to be increased. The friction windage and core losses will be about the same in either case.

Changes Required by Addition of Steam Lap—What changes besides adding steam lap would be necessary in changing a lapless slide-valve engine to one with lap to obtain earlier cutoff? E. W.

The addition of steam lap makes the admission later as well as cutoff earlier, and therefore when lap is added it becomes necessary to advance the eccentric to obtain early enough lead or opening of the steam port at the beginning of the stroke. As the advance of the eccentric results in advancing the time of all valve events, it causes earlier release and more compression by earlier closure of the exhaust. To leave the points of release undisturbed from advancing the eccentric, it is necessary to add lap on the exhaust side of the valve, and that will be accompanied by earlier closure of the exhaust port and still higher compression of the exhaust.

Size Required for Duplex Pump—What size of water cylinders would be required for a double-acting duplex pump to fill a 14,000-gal. tank in 40 min.? M. A. R.

Assuming a piston speed of 45 ft., or 540 in., per min. and 7 per cent. for reduction of capacity by slippage and reduction of effective piston area by the piston rod, the cross-sectional area of each water cylinder would need to be

$$\frac{14{,}000 \times 231}{2 \times 540 \times 40 \times (1.00 - 0.07)} = 80.49 \text{ sq.in., or } \sqrt{\frac{80.49}{0.7854}} = 10.1 \text{ in. dia.}$$

A duplex pump having 10-in. diameter × 12-in. stroke water cylinders would be the nearest commercial size, and running under other conditions as stated would need to be driven at a piston speed of $45 \times \frac{(10.1)^2}{(10)^2} = 45.9$ ft. per min., or practically 23 r.p.m.

Measuring Indicator Diagrams—How does the ordinate method of measuring indicator diagrams compare with the accuracy attainable with a planimeter? E. R. M.

For determining the average height or m.e.p. of ordinary forms of diagrams, the results of measurements made by the method of ordinates may be equally as good for all practical purposes as when made with the planimeter when performed with equal skill and care, though measurement by the planimeter may be more rapid and convenient. The commonest error made in applying the method of ordinates arises from imperfectly scaling the heights of the middle ordinates. For this the most accurate method is to take a strip of paper having a straight edge and, beginning with a zero point located near one end of the strip, transfer a summation of the heights along the edge of the strip of paper. Then use a rule or scale that is long enough to make a single measurement of the accumulated heights and obtain the average height by dividing this summation by the number of middle ordinates.

Use of Altitude Gage on Force Pipe—How can readings of an altitude gage connected on the discharge side of a pump be employed for determining whether a standpipe is filled to overflowing? E. C. B.

With the pump at rest, ascertain the reading of the altitude gage when the standpipe is filled to overflowing, and while maintaining an overflow, take readings for different rates of discharge, as for instance for different speeds of the pump, assuming that there is a constant percentage of slippage. When the pump is running, the gage connections should be dampened to overcome pulsations of pressure. The difference between readings taken while the pump is running at any particular speed and the static, or standing, pressure obtained with the pump at rest will be the loss of pressure due to pipe friction at that rate of discharge. Having thus ascertained the loss from friction for different rates of discharge, the true altitude may be known at any time while the pump is running by deducting the loss due to the rate of discharge from the indication of the gage.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Safe Practices for Boiler Rooms

SYNOPSIS—The National Safety Council, with a committee of 50 safety experts working out the maximum and minimum requirements in safeguarding, have summed up the findings of the experts in the Council's monthly safe-practice leaflets, one of which is of interest to power-plant operators, as it deals with conditions as they should be found in the boiler room.

The first law in the boiler room is order, the second is care, and the third is space. The leaflet dealing with boiler rooms points out that in a carelessly kept boiler room the stumbling hazard is ever present in an aggravated form. This applies to loose coal being scattered on the floor, steam hose carelessly thrown down, wheelbarrows left projecting from dark corners, planks behind doors and scores of other hazards inviting accidents. It points out that sufficient space should be provided in front of boiler furnaces so that the fireman may have free use of the firing tools and be able to withdraw the longest tool from the furnace without inconvenience. Tool racks are also recommended, built in a substantial way, and so as not to form obstruction. Racks recessed in walls are usually satisfactory.

A section is given to flooring, wherein it is pointed out that different types of floors may be used around the boiler setting and under the coal piles, but that the floor immediately around boilers should be of metal plate with abrasive surface or of concrete.

As to the matter of fuel storage, where coal is dumped from railroad cars into a hopper, a metal grating should always be used near the top of the hopper to prevent anybody from falling into it. A workman entering a coal bin should wear a safety belt and life line, the upper end of which should be securely attached to some stationary object, and a companion workman should keep the line adjusted short enough to prevent a man in the bin from being drawn under the material.

FENCED RESERVOIR

It is recommended that where a reservoir is used as a water supply, it should be fenced to a height of at least 7 ft. Eighteen inches or more should be allowed between the fence and curbing for use in cleaning or emergency work, and gates should be securely locked and admittance refused to any except specified workmen. If the side walls of the reservoir are perpendicular or the slope is at a sharp angle, a safety grab rail at about the water level will aid in preventing a serious accident.

In the case of hotwells less than 15 ft. in diameter, the surface may be substantially covered with metal plates a foot or more above the water level. If the hotwell is more than 15 ft. in diameter, grating 6 ft. or more from the side of the well may be installed. Closed hotwells should be provided with a pipe at least 10 ft. high and of sufficient diameter for the escape of vapor.

In the economizer the temperature of the water is raised to nearly that of the boiler. As the economizer is under the same pressure as the boiler, precaution should be taken to maintain and operate it with the greatest care. The water should enter the boiler after passing through a check valve which will not permit a return.

Naturally, each boiler should have its own steam gage attached by means of a siphon, and one recording gage is recommended to be connected with each steam system so that should an accident occur, there will always be available a record of the steam pressure at that time.

In regard to gage-glasses, water columns, etc., it is recommended that each boiler shall be equipped with a water column and fittings in a manner to so locate them that a view of the gage-glass from the boiler-room floor is not intercepted by stairways, platforms, etc. Where it is necessary to provide a special platform for the water tender, it should not interfere with a view of the gage-glass from its position on the boiler-room floor, because it may be necessary to verify the water level from this point. The water column should be of a design approved by the A. S. M. E. Code and conform to their recommendations regarding angle, cocks and try-cocks. The gage-glass shield should be capable of being rotated about the glass while work is being done upon the water column, such as the insertion of new glasses, packing, etc. Drain connections from the water column should have an open end into the ashpit and be of sufficient size to permit foreign material that may enter the column to be blown out.

Operating rules for boilers are as follows:

If a boiler in a battery that is in service has been out of use for a time sufficient to permit all parts of the setting to become cold, or if it is a new boiler, the following method of starting it up is advised:

The stop valve between the "gooseneck" and the header should be tight; the drain pipes in the "gooseneck" and the drain valve underneath the nonreturn valve should be open; and the connection to the steam gage should be open and in good condition.

Open the feed valve and fill the boiler gradually until the water level stands between the first and second gages.

STARTING FURNACE FIRES

Start a light wood fire in the furnace and have the damper in the stack practically closed. The escape of smoke under such conditions from the setting will indicate any air leaks, unclosed doors or other defects. If any such leaks are observed, they should be corrected before going further (or in case of a new boiler, or a boiler with new brickwork in the furnace this preliminary heating should be continued for a day or two if possible before going further). Continue the firing with gradual addition of coal, the damper being adjusted to the requirements until all the air is driven from the boiler and steam is escaping from the proper channel. In a period of at least two hours the steam pressure in the boiler should be brought up practically to that of the pressure in the header, but, as stated, if the boilers are new a much longer time should be taken.

While the steam pressure is rising, the gate valves between the boiler and the steam main should be slowly opened. This leaves the boiler still shut off from the main by the nonreturn valves. When the pressure on the boiler has reached the required point, the nonreturn valve will open automatically, placing the boiler in connection with the main steam system.

Before commencing heavy firing, corresponding to the service in the remainder of the battery, lift the lever on the safety valve (if of the lever type) to see that it is free to act, and observe at the earliest opportunity whether this valve lifts at the allowed pressure of the boiler or under that pressure. At this time the stop valve in the boiler-feed pipe near the feed main of the boiler house should be wide open, also the stop valve between the check valve and the boiler; the feed-controlling valve should be adjusted by the water tender to an opening such as will provide the required water delivery.

CHECKING FURNACE FIRES

The practice of checking fires by opening the fire-doors so as to permit an inrush of great quantities of cold air into the boiler setting and to the stack is bad from an economic standpoint and subjects the boiler and setting to undesirably rapid changes of temperature. Instead of this it is suggested that ash-doors or other draft supply be closed, and that, if further checking is necessary, the dampers be closed Finally, if necessary, open the fire-doors gradually.

The bottom blowoff should be used at least once every twelve hours, the valves in the blowoff connections being left open for a period of one-half minute or longer, depending upon the character of the feed-water supply. A boiler should not be emptied before the setting has cooled.

If for any reason a boiler is to be taken out of service for cleaning, etc., the following procedure should be observed:

Check the dampers and allow the fires to burn out, at which time the nonreturn valve will be seated; also close the gate valve in the branch next to the header and open the drains in the "gooseneck." Shut off the stop valves in the feed pipe.

Rapid cooling sets up undesirable strains in the equipment. Cool as slowly as time will permit. A small amount of air may be passed through the furnace to assist in the cooling. To do this open the doors and dampers slightly.

After the boiler is cool the blowoff valves may be opened and the boiler drained.

If for any reason the boilers are to be laid up indefinitely, the following precautions should be taken to provide for safe conditions when the boilers are again put into service.

Thoroughly drain the drums and tubes and clean them inside and outside. Then completely fill the boiler and re-

place the covers which have been removed. This method is not practicable when the boilers could freeze. In some cases, after cleaning boilers, dry them thoroughly and place a pan of lime in each drum to absorb the moisture. Do not replace the manhole covers. Some companies prefer to clean and dry a boiler and then smear the inside of the drums and tubes with a heavy crude oil or fuel oil. This should be put on with a swab, and when putting this on in a drum an electric lamp should be used, and not an open torch. Drums and tubes should be left open. Mud drums, headers and tube caps should all be cleaned and similarly coated.

In all places where freezing may occur, care should be taken to drain the water from all parts or fittings, or where these cannot be drained (as in the case of steam gages), they should be moved and stood in warm places. It is assumed that the boiler is separated from the main header by two valves, a gate and a nonreturn. In case this condition does not exist, or if the valves leak, a blind flange must be inserted between the boiler and the header.

The blowoff valves, stop valve in the "gooseneck" next to the steam header and the stop valve in the feed pipe next to the feed header should all be locked shut and the keys retained in the possession of the man in charge of the subsequent cleaning operations. Place on the handle of all these valves a suitable sign as follows: "Man Inside Boiler; Do Not Touch."

Manhole covers may be then removed and the boiler opened up for cleaning. It should be an invariable rule that the man who enters the boiler for the purpose of inspection, and who is in possession of the keys locking the aforementioned valves, must give the final assent for the return of the manhole covers to their places.

Previous to entering the boiler it is advisable to determine whether there is any gas or bad air present, by passing a torch or candle inside.

For locking the valves, as previously advised, the following method is suggested: Make a loose cover for the handwheel of the valve out of sheet steel. This cover is simply a circular box made in halves and hinged at one side, with a hole in the bottom for the valve stem. On the side opposite the hinge an arrangement is made for attaching the lock, so that the box can be locked shut. This box can be painted bright red, with the word "Danger" in another color. For large steam valves this box may also have a sleeve extension to cover the valve stem, thus preventing the use of a wrench on the stem of the valve.

The cleaning of the setting of coal-fired boilers should not be commenced until all the flue dust and other material, also the walls of the settings, have been reduced to a temperature where there is no possibility of a man being burned by coming in contact with them.

The cleaning of gas-fired boilers will necessitate an additional precaution in the way of testing the chambers by means of lighted candle or torch to detect the presence of gas or bad air before a man undertakes to operate therein, and furthermore, the gas valve leading to such a boiler should be locked shut and the key retained in the possession of the man in charge of the subsequent cleaning operations. A sign, "Man Inside Boiler; Do Not Touch," similar to that to be placed on the steam feed and blowoff valves, is to be placed on this valve also.

If for any reason, such as blowing out of gaskets, vibration, overstraining of pipes or general deterioration, the joints of steam pipes develop objectionable leaks, the application of wrenches to the bolts of such joints while under steam pressure should be absolutely prohibited. If such joints are to be repaired, it should be done after the pressure has been removed from the particular section where the trouble occurs.

If the tubes of a fire-tube boiler develop leaks at the tube sheet, expanders should not be applied to the ends of the tubes while the boiler is under steam pressure.

If a leak develops at any part of the sections of a boiler, whether in the headers to which the tubes are attached or at a riveted joint, the use of a calking tool to stop this leak while the structure is under steam pressure should be prohibited. This applies to rivets as well as plates, and all such repairs should be made after the steam pressure has been taken off the boiler.

If a leak develops at the handhole plate or around the tube caps of water-tube boilers, it should not be stopped by tightening up the bolts while steam pressure is on the boiler.

If a leak develops at a manhole cover, it should not be stopped by tightening the bolts in the yoke while the boiler is under steam.

Rising stems of valves should not be permitted to become incrusted or covered with dirt so that they cannot be moved the full extent of their travel at any time. A periodic inspection, not less than once a month, of all valves, stems, etc., in all the main piping systems about the boiler house is recommended. Too much importance cannot be attached to keeping the valves in such condition that they are always ready for use.

Steam should always be admitted to empty piping very slowly.

If any portion of piping has remained unused for an hour or more, it is important that it be completely drained before steam is again turned into it.

Water columns should be blown out completely at least twice every turn. If a gage-glass is fouled internally, so that the water level is not clear, the glass should be cleaned or replaced as soon as possible. If the fouling of the gage glass occurs frequently, it is due to some characteristic of the water, such as suspended matter, scale solvents, lubricating oil, etc., for which some remedy should be devised.

Try-cocks shall be used at least twice every turn, which regular use will keep them in good working order.

The Providence Engineering Society Discusses Fuel Oil

Tuesday evening, Mar. 6, Frederick Ewing, sales engineer for the Mexican Petroleum Co., addressed the Providence Engineering Society on "Fuel Oil for Steam Boilers." The meeting was the first of several to be held this season by the Power Section Committee.

Mr. Ewing laid emphasis on the large saving in labor possible in large plants where oil was used instead of coal. Several cases were cited, but one of the most noteworthy was that of a steamship which employed 365 firemen and coal passers with coal as the fuel, while but 32 were needed after the change to oil. The advantage is more than a reduction in labor cost. There are fewer men to handle, and an appreciable shortage of men just before sailing is less likely. On this ship, said the speaker, the boiler-room temperature was reduced several degrees under what prevailed when coal was used.

Mr. Ewing cautioned against asserting that so and so many barrels of oil were equivalent to a ton of coal. The United States Geological Survey, he said, had found that for well-known oils and coals, the oil equivalent of a ton of coal varied from 4.2661 to 3.661. Although one would assume that when making a statement of comparative values the statement should be qualified, this often is not done, which leads to disagreeable misunderstandings.

With oil the draft is not regulated the same as is done with coal. With the former the ashpit doors are left open all the time, and the uptake damper regulates the volume of air admitted to the furnace. To show the importance of close draft regulation the speaker gave the following figures from test by the Stone & Webster Construction Co.:

Oil Temperature	Oil Pressure	Atomizer Pressure	Draft	CO_2
130	10	50	0.05	12
130	12	65	0.00	14

The speaker said that with oil particularly, a balanced-draft furnace was most desirable. He recommended 0.02 in. as the best furnace draft, stated in a general way. Excess draft is far more common with oil than with coal because of the absence of such resistance as a fuel bed.

Proper preheating of the oil is too often neglected, said Mr. Ewing. Every oil has characteristics that make some particular preheating temperature the best to use. If the preheating temperature is too high, the oil will deposit carbon at the burner, seriously impairing the ability of the latter to function rightly by filling it with the carbon. If too low, the oil will not vaporize well.

Carbon will be deposited usually if the temperature is more than 145 deg. F. at the burner. A temperature of 80 or 90 deg. F. in the tanks gives good results. The reason for heating the oil in the tanks is so it may be made liquid enough to be handled readily by the pumps; if too hot, it tends to gasify; if too cold, it is too viscous to flow well. Both of these give trouble in pumping.

During the discussion a user of oil said that at his plant it was necessary to use a supply line from tanks to burners 500 ft. long. This line crossed a street, coming very near the surface to avoid a sewer pipe and just enough below the surface to be safely beneath the car tracks. During all the continued cold of the winter, this gentleman said, there was no trouble because of cold oil. This plant is in Providence. The circulating system is used, and the oil surplus returning to the tanks is always several degrees higher than that leaving, thus assisting in heating the supply. The cold test of the oil used is 32 deg. F.; that is, it is too viscous at 32 deg. F. to flow.

Speaking of burners, Mr. Ewing said that repeated tests had shown that the variation in efficiency of many different burners was only from 3 to 5 per cent. More important than the type of burner selected is the layout and completeness of the installation as a whole. The oil-handling system should be in duplicate; that is, there should be duplex pumps, duplicate oil feeder lines, and the system should be of the circulating type so that the surplus oil, which is heated, would return to the tanks, which should be in duplicate. The condensation from the line carrying steam for vaporizing the oil should be so arranged as to prevent the condensate getting into the burner. The steam and oil lines should be insulated, a job too often neglected. Draft gages should be regarded as important as are the burners, for it is extremely difficult, if not impossible, to regulate the air supply most advantageously without them.

The speaker deplored the lack of storage capacity at most oil-burning plants. In many he said there was only a day's storage capacity provided. Every plant should have from three to four weeks' supply. Few engineers or plant owners would think of having as little as one or a few days' coal supply on hand. Because some of those plants in cities like Providence, for example, where the oil company has large storage tanks and excellent delivery service, had never yet been "stuck" because of no oil was no reason to overlook the possibilities of traffic tie-ups, even of powerful motor trucks, that New England snowstorms may produce.

Deliveries to plants 10 or 12 miles from the oil company's supply base are made by motor trucks. Several plants are 60 to 70 miles from tidewater in New England, and these are supplied by tank cars.

Replying to an inquiry as to the visible supply of oil, Mr. Ewing said that of course it was not as great as coal; but that it was estimated as 25,000,000 bbl. for at least 70 years. It should be remembered, he said, that new oil fields are being found all the time; Oklahoma, California, Mexico, Colombia and South America were mentioned. There soon will be 10,000,000 bbl. storage in the United States. A gentleman present stated that he recently read a report that 20 billion barrels of oil were available from Colorado shale.

Asked if the Mexican oil was suitable for Diesel engines, the speaker replied that it was for the Swedish and De La Vergne Diesels only.

Bearing on the continuity of supply and competing price of oil with coal, it was asked if the speaker or anyone present knew of a consulting engineer in the East who had been daring enough to recommend to his clients a large plant built on an oil-burning basis; that is, without bunker capacity, stokers, coal- and ash-handling machinery, chimney, etc., all of which tended to enlarge the initial investment. Mr. Ewing knew of one—the new station of the Tamarack mills at Pawtucket, R. I., designed by Jencks & Ballou, engineers, Providence. Mr. Ewing was not certain if only 60 per cent. of the cross-sectional area of chimney was used, compared with what would be 100 per cent. if coal were the fuel, specified capacity considered.

"Power" is now preparing a description of the chief features of the Tamarack station.

The fear of objectionable smoke from oil seemed to weigh heavily on the minds of many of those present, but it was generally agreed that unless the setting was altogether unsuited, smoke should be the least of the operator's worries. The plant of the Jencks Spinning Co. at Pawtucket, for example, forces its boiler to 200 to 275 per cent. of rating without smoke. Oil is the fuel.

Several heating plants in Providence have been using oil successfully, burning it in a low-pressure burner of the rotary mechanical type. The advantages are quick steaming and no banking of fires.

Industrial Safety Exposition

During the week ending Mar. 10 the Ohio Industrial Commission held at Columbus its third annual industrial safety exposition in the interest of accident prevention, industrial health and hygiene and fire prevention. The exhibitors comprised the State Industrial Commission, the safety departments of a number of the railroads, manufacturing companies, business houses and public-service companies. There was naturally considerable duplication, and the effect of this on some was a loss of interest, while to others it accentuated the extent of safety work in industries.

It is to be hoped that each state will soon have large technical museums for the permanent display of all manner of safety devices, fatigue reducers and many other things of technical and industrial interest.

Among the exhibits were safety goggles, wheelbarrow-handle protectors, stay-bolts, safety lathe dogs, glass guards against lathe chips, safety emery-wheel dressers, dust catchers and conveyors, molders' shoes, etc.; statistics of the number of accidents and deaths in the industries of the state and their cause; alcoholic contribution to disease and accidents; models on a small scale of badly lighted and well-illuminated factories, showing by contrast the probability of more accidents in the former; the danger of carelessness on streets on the part of pedestrians, drivers, chauffeurs, children at play and street-car passengers.

The boiler-inspection department showed samples of grooved and cracked sheets, rivets in unreamed holes, bagged plates and tubes, tubes bursted because of defective welds, scaled feed pipe, wasted stay-bolts, dirt-covered pressure gages and obsolete safety valves, giving evidence that there are still owners of boilers who are not as careful as could be desired.

A model by the American Rolling Mill Co., on a scale of ¼ in. to 1 ft., of an openhearth furnace, its equipment and the surrounding building, with all the safety features connected therewith painted green, took 5½ months for construction.

Such public expositions help the public to realize what can be done to reduce accidents and the duty of each to help attain this end.

The Alumni of Stevens Institute Organized for Defense

For the last year the alumni of Stevens Institute of Technology have been actively engaged in measures for military and industrial preparedness, so that the present emergency has not taken them by surprise. Acting through their committee on military and naval affairs, there is now being compiled a classified list of Stevens men willing and ready to serve in such branches of the Army or Navy as their specialized education and experience will prove of most value in the Government service. Many Stevens men have already been commissioned in the Officers' Reserve Corps. Some are officers in the Regular Army, the Navy and the National Guard, while others are doing special work in ordnance and in naval engineering.

This enrollment is being carried on under the auspices of an advisory committee consisting of: Alexander C. Humphreys, president, Stevens Institute of Technology; John W. Lieb, vice-president, New York Edison Co.; Robert M. Dixon, president, Safety Car Heating and Lighting Co.; Anson W. Burchard, vice-president, General Electric Co.; William D. Hoxie, vice-president, Babcock & Wilcox Co.; Newcomb Carlton, president, Western Union Telegraph Co.; William A. Field, general manager, United Alloy Steel Corporation; Charles H. McCullough, Jr., vice-president, Lackawanna Steel Co. The active committee is composed of J. H. Cuntz, L. K. Lydecker, B. F. Hart, Lewis Sanders, W. R. King, Henry Torrance, E. H. Peabody, G. G. Freygang.

NEW PUBLICATIONS

OPERATION OF GAS-WORKS. By Walter M. Russell. Published by McGraw-Hill Book Co., Inc., New York. Cloth; 209 pages; 6x9 in.; 76 illustrations. Price, $2.

This volume has been compiled with the purpose of presenting facts and details of gas-works management in a concise and readable form as relating to modern practice. It is intended to supply the needs of the foreman, superintendent, engineer and others who are connected with small or medium-sized gas-works and who desire to widen their knowledge of the principles and practice of gas making. The author has not made an attempt to describe to any great extent gas-works apparatus, but has rather striven to give instructions for operating the standard types of apparatus usually found in gas-works, with some discussion of the principles involved. It is stated that the methods treated in the volume have been successfully tried out on a commercial scale. There are six chapters, dealing with Organization and Management, Chemical Control, Coal Gas, Water Gas, General Plant Operation and Calorimetry and Photometry respectively. The volume has numerous tables.

ELECTRICAL EQUIPMENT. By Harold W. Brown. Published by McGraw-Hill Book Co., New York, 1917. Cloth; 9x6 in.; 229 pages; 109 illustrations; 16 tables. Price, $2.

This book treats of electrical equipment, its selection and arrangement with special reference to factories, shops and industrial plants. The purpose is to show how to apply the great mass of electrical data now available in the various handbooks and other technical literature and the principles laid down in textbooks to the equipping of various industrial

plants. The work is divided into 22 chapters, which briefly outline the following subjects: The circuits of power plants and distribution systems, the requisites of power plants and distributing systems, choice of distributing systems, direct-current and alternating-current motors, motor generators, converters and rectifiers, transformers and auto-transformers, storage batteries, lumination, direct-current and alternating-current transmission and distribution systems, direct-current and alternating-current generators, regulating transformers, instrument transformers, controlling, regulating and circuit-breaking equipment, lightning-arrester equipment, measuring and indicating apparatus, motor applications and costs.

The tables given in the chapter on motor applications are a very important part of the work. One gives the type of motors best suited to driving some sixty different kinds of machines in various industries. The other, an eight-page table, gives formulas for calculating the sizes of motors for driving metal-working machinery, wood-working machinery, cranes, hoists and telphers, conveyors and belt elevators, cement plants, pumps and compressors, steel plants and refrigerating plants; after which examples are worked out illustrating the application of these formulas. In the chapter on costs is given a 16-page table for arriving at the approximate net cost in dollars of the various kinds of electrical equipment.

The work closes with a chapter of 56 problems dealing with the various applications of motors. Both the text and the problems are drawn largely from the author's experience as engineer with the Westinghouse Electric and Manufacturing Co., in the detail and switchboard divisions. Throughout the work many references are made to the "Principles and Practice of Electrical Engineering," by Alexander Gray, the "Standard Handbook for Electrical Engineers" and the "American Handbook for Electrical Engineers." The book is primarily intended to guide college students in laying out their work and to assist mechanical and electrical engineers in selecting electrical equipment, and in this capacity it should find a wide field of usefulness.

BULLETIN ON ELECTRIC ARC WELDING

A 38-page booklet entitled "Arc Welding" has been issued by the Arc Welding Machine Co., New York City; price, $1. This bulletin is intended for purely educational purposes to bring about an appreciation of the progress that has recently been made in the process of electric-arc welding. Comparisons are made between oxyacetylene gas and the electric arc as heat producers and their application to the different classes of welds. Multi-string welding is discussed at some length, and a number of curves are given to show the effect of this type of welding upon the strength of the weld. In the description of the constant-potential and constant-current systems curves are given showing various characteristics of the arc. The different methods of controlling an arc are considered and the effect that these methods have upon the temperature of the metal in the weld. Stress is laid upon the advantages of the constant-current closed-circuit system with self-regulating generators, as this system does not break the arc, therefore does not burn the metal. Installation costs and relative floor areas for equal capacities of different production welding plants are given. The booklet closes with two tables giving itemized comparisons of welding systems with plant capacities of 1,200 welds per 9-hr. day. This bulletin is written in a very readable style, has many illustrations, and should be of interest to those having to do with electric-welding processes.

PERSONALS

E. A. Earl, who was connected with the engineering department of the Hyatt Roller Bearing Co., Harrison, N. J., has accepted a position as chief engineer of the Radnor mill, Jessup & Moore, Elkton, Md.

John O. Olson, who for over 13 years has been chief engineer with the Lee Light and Power Co., of Clarinda, Iowa, has resigned to accept the position of chief engineer with the Hubbard Ice Co., of Cedar Rapids, Iowa.

Irwin Newman, consulting engineer, of Chicago, is now representing the Reeves-Cubberly Engine Co., of Trenton, N. J., and the D'Olier Centrifugal Pump and Machine Co., of Philadelphia, Penn., at 945 First National Bank Building.

Frank G. Philo has resigned the position of efficiency engineer for the Lehigh Navigation Electric Co. and its affiliated companies to accept the position of assistant chief engineer of operation of the New York Steam Co. and the Burling Engineering and Construction Co., of New York City.

ENGINEERING AFFAIRS

The Pittsburgh Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on Apr. 21, at the Fort Pitt Hotel. The meeting will be under the auspices of the Standardization Committee.

The Combined Associations of the N. A. S. E. of Manhattan, Bronx and Queens will hold their annual dinner, entertainment and dance at the Hotel Netherland, 59th St. and Fifth Ave., New York City, on Saturday, Mar. 31, at 8:30 p.m.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hold a meeting on Apr. 7 at the Majestic Hotel. Karl A. Pauly, of the General Electric Co., will present a paper entitled "Variable Speed Control of A. C. Motors."

The American Society of Safety Engineers will hold its regular monthly meeting on Mar. 31, at the Engineering Societies Building, 25 West 39th St., New York City. H. B. Furlong, who was in charge of lock construction at the Panama Canal, will deliver an illustrated lecture on the canal.

The American Society of Heating and Ventilating Engineers announces that its president, J. Irvine Lyle, has appointed two committees. One is a Committee to Formulate a Standard Code for the Testing of Low-Pressure Heating Boilers, and consists of the following members: Homer Addams, chairman; John R. Allen, J. J. Blackmore, Ralph Collamore, William H. Driscoll, W. L. Fleischer, L. A. Harding, James F. McIntire, Edwin A. May, P. H. Seward, W. S. Timmis. The other is a Committee to Provide for the Establishment of a Bureau of Research, which shall be conducted under the auspices of the society. The members of this committee are: George W. Barr, chairman; H. M. Hart, J. D. Hoffman, William F. McDonald, W. W. Macon, J. W. H. Myrick, Perry West.

MISCELLANEOUS NEWS

A Reduction in Rates for Electric Service has been announced by the Alabama Power Co. from 12 to 10c. per kw.-hr. with discounts, so that 9c. will be the maximum paid, the minimum bill, however, being one dollar. The new rates were made to go into effect Mar. 1 and affect Decatur, Albany and suburbs, and Hartselle, Ala.

Dividends Have Been Increased and Rates Reduced by the Consolidated Gas and Electric Co., of Baltimore, Md., by action of the directors. A quarterly dividend of 2 per cent. has been declared, as against 1¾ for the previous quarter, and a reduction from 8½ to 8c. per kw-hr. with a 75c. minimum charge is ordered. It is estimated that $200,000 will be saved per year to consumers.

BUSINESS NOTES

Walter Kidde, engineer-constructor, of 140 Cedar St., New York, has incorporated his organization under the title of Walter Kidde & Co., Inc.

The De Laval Steam Turbine Co., Trenton, N. J., announces the opening of a district sales office in the Smith Building, Seattle, Wash., in charge of William Pullen.

The Homestead Valve Manufacturing Co., of Homestead, Penn., announces that the following firms will represent it in their immediate vicinities: Queen City Supply Co., Cincinnati, Ohio; Root, Neal & Co., Buffalo, N. Y.

The Buffalo Forge Co., Buffalo Steam Co. and Carrier Air Conditioning Co. announce the removal of their Pittsburgh (Penn.) office on Apr. 1, from the House Building to the New Union Arcade. H. Lee Moore will continue in charge.

The Dodge Manufacturing Co., of Mishawaka, Ind., has purchased the properties of the Oneida Steel Pulley Co. and Keystone Steel Pulley Co., of Oneida, N. Y., having acquired the interests through incorporation of the Dodge Steel Pulley Corporation, which becomes subsidiary to the Mishawaka concern. M. W. Mix will head the companies.

The Babcock & Wilcox Co., in an open letter, states that, after an investigation on its part of the various mechanical soot blowers, it has decided to adopt Diamond soot blowers as built by the Diamond Power Specialty Co., of Detroit, as being best adapted for use in connection with B. & W. boilers, and shall hereafter recommend their use with them.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago
Buckwheat	$3.40@4.40	$3.05@3.20	$5.50@5.75	$3.25@3.50
Rice	.....	2 50@2.65	.....	2.70@2.95
Boiler	2.75@3.75	.....	.....	.....
Barley	2.65@3.65	2.20@2 35	.....	2.35@2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago
Clearfields	$5.90@7.00	$1.45@2.00	$11.50@11.75	$4.25@5 00
Cambrias and Somersets	6.15@7.25	1 60@2.15	11.75@12.00	4.60@5.40

Pocahontas and New River, f.o.b. Hampton Roads is $7@7.25, as compared with $2.80@2.85 a year ago; on cars Boston price is $13@14, against $5@5.25 a year ago.

*All-rail rate to Boston is $2 60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago
Buckwheat	$2.75	$2.75	$5.25@5.50	$3.50@3.75
Rice	2.20	2.25	4.75@5.25	2.65@2.75
Barley	1.95	1.75	4.00@4.50	2.30@2.40

BITUMINOUS

	South Amboy	Port Reading	Mine Price
Clearfield	$6.75@7.25	$6.75@7.25	$5.25@5.50
South Forks	7.00@7.25	.....	5.25@5.50
Nanty Glo	7.00@7.25	.....	5.25@5.50
Somerset	6.75@7.00	6.75@7.00	5.00@5.25
Quehamoning	7.00@7.25	6.75@7.00	5.25@5.50

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago
Buckwheat	$2.50	$1.55	$3 40	$2.30
Rice	2.10	.90	3.00	1.80
Boiler	1.95	....	3.15	....
Barley	1.85	.55	2.05	1.30

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Mar. 17, 1917	One Year Ago
Slack	$4.00@4.25	$1.10@1.15
Mine-run	4.00@4.25	1.15@1.30
¾-in.	4.00@4.25	1.25@1.40

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current price per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam Lump	.....	$2.75@3.50	.....	$2.50@2.75	$2.50@3.00
Lump	$3.50@3.75	3.50@3.75	$5.00	2.50@3.00	3.00@3.50
Egg	3.50@3.75	3.50@3.75	5.00	2.50@2.75	2.50@2.75
Nut	3.50@3.75	3.50@3.75	.....	2.50@2.75	2.25@2.50
No. 1 nut	3.50@3.75	.....	.....	.....	.....
No. 2 nut	3.50@3.75	.....	.....	.....	.....
No. 3 nut	2.75@3.25	.....	.....	.....	.....
No. 1 washed	3.50@3.75	.....	.....	.....	.....
No. 2 washed	3.50@3.75	.....	.....	.....	.....
Mine-run	3.00@3.25	3.00@3.25	4.75@5.00	2.25@2.50	2.50@3.00
Screenings	2.75@3.25	2.75@3.25	.....	2.00@2.50	2.00@2.50

Splint lump, $4.25@4.50.

St. Louis—Price per net ton f.o.b. mine a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago	Mar. 17, 1917	One Year Ago
6-in. lump	$2.75@3.00	$1.50@1.75	$2.75	$1.25@1.50	$1.50@1.75	$1.10@1.25
2-in. lump	2.75@3.00	1.40@1.50	2.00	1.20@1.35	1.40@1.60	.95@1.10
Steam egg	2.75@3.00	1.40@1.50	2.00	1.20@1.30	1.35@1.35	.90@1.10
Mine-run	2.50@2.75	1.10@1.15	1.75	1.10@1.15	1.25@1.35	.90@1.00
No. 1 nut	2.75@3.00	1.30@1.50	2.00	1.25@1.40	1.40@1.50	.90@1.00
2-in.screen.	2.50	.90@1.00	1.75	.75@ .90	1.40@1.50	.65@ .80
No. 5 washed.	2.40	.90@1.00	1.65	.75@ .90	1.40	.75@ .85

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run		Mine-Run
Pratt	$3.25@3.50	Carbon Hill	$2.75@3.00
Big Seam	2.50@3.00	Cahaba	3.25@3.50
Black Creek	3.25@3.50		

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Anniston—The Alabama Power Co. plans power plant. E. S. Center, Jr., Birmingham, Pur. Agt.

Ga., Thomasville—City plans to issue bonds to improve the electric-light plant.

Ill., Keithsburg—City will construct an electric-light plant.

Ill., Peoria—The Central Illinois Light Co. has increased its capital stock from $5,500,000 to $20,000,000 and will extend its plant and install additional equipment.

Ill., Springfield—The Springfield Light, Heat and Power Co. soon receives bids for an additional plant.

Kan., Bronson—City plans holding an election in April to vote on $15,000 bonds to install an electric-light plant. W. B. Rollins & Co., 209 Railway Exchange Bldg., Kansas City, Mo., Engr.

Kan., Newton—City is having plans prepared for an electric-light plant.

Kan., Waverly—City has had plans prepared for improving its electric-light plant.

Ky., Paducah—City has retained F. G. Proutt and A. L. Dabney, C. E., to make plans for improving the electric-light plant.

Ky., Whitesburg—W. W. Gibson & Son is having plans prepared for an electric-light and power plant.

Mass., Brookline—The New England Fireproof Construction Co. has had plans prepared for a private electric plant. G. B. Washburn, 6 Beacon St., Boston, Arch.

Mich., Alma—The Central Michigan Light and Power Co. will build a power house on Pine River. Estimated cost, $150,000.

Mich., Petoskey—City will improve its electric-light and power plant.

Minn., Foley—The Public Service Comn., St. Cloud, has had plans prepared to extend its high-tension transmission line from St. Cloud to Foley. A. J. Hakes, Supt.

Minn., St. Paul—The Twin City Rapid Transit Co., 1 South 11th St., Minneapolis, has had plans prepared for a 1-story, 200 x 240-ft. substation. Estimated cost, $25,000. H. Lowry, Pres.

Miss., Gulfport—J. T. Connell, Dir. of Works, is receiving bids Mar. 27 for installing an electric system on the grounds and in the buildings of the Mississippi Centennial Exposition.

Mo., Barnard—The Maryville Electric Light and Power Co., Maryville, plans to construct a 3-phase, 22,000-volt transmission line from Maryville to Barnard, 15 mi., and will install a 300- to 350-kva. generator directly connected to a Corliss engine.

Mont., Geraldine—W. J. Bentson and J. Rose have been granted a franchise to install an electric-light plant.

N. J., Elmer—The American Railways Co., subsidiary of the National Properties Co., Wilmington, Del., will install an electric-lighting system.

N. Y., Franklin—The Delaware & Otsego Light and Power Co. will install a transmission line from Franklin through Treadwell to Meridale, 14 mi., and possibly to Sidney Center, additional 5 mi. E. D. Mackey, Mgr. L. F. Burnette, Mgr.

N. Y., Roosevelt—City will install an electric-light plant.

N. D., Hebron—The Hebron Electric Light and Power Co. will install short extensions to its transmission lines to connect with several consumers in outlying districts.

N. D., Valley City—City will receive bids Mar. 19 for an underground heating system. M. J. Boyd, City Audr. W. Doud, Old Colony Bldg., Chicago, Engr.

Ohio, Cincinnati—F. E. Wesselman, Pres., Longview Hospital for Insane, is receiving bids Mar. 21 for extensions to the power plant. Estiamted cost, $60,897. Elzner & Anderson, Ingalls Bldg., Arch.

Ohio, Oberlin—City will install an electric-light plant.

Okla., Bremerton—City plans to extend its transmission line to Mountain Park, 2½ mi. T. H. Kenedy, Supt.

Okla., Maysville—City plans to install an electric-lighting system.

Ore., Bend—Bend Water, Light and Power Co. will construct an addition and distributing system. Estimated cost, $50,000. K. B. Miller, Engr.

Ore., Marshfield—City plans to hold an election to vote on bonds to install an electric-light plant.

Penn., Conyngham—The Harwood Electric Co., Hazleton, will install an electric-lighting system. E. Hughlies, 437 Chestnut St., Philadelphia, Pur. Agt.

Penn., Hazleton—The Harwood Electric Co., subsidiary of the Lehigh Navigation Electric Co., is having plans prepared for electric systems for public and private service in all boroughs and towns within a radius of 25 mi.

Penn., Lititz—The Edison Electric Co., Lancaster, will install a transmission line from Lititz to Mount Hope. R. B. Hull, Lancaster, Gen. Mgr.

Penn., Philadelphia—The Ketterlinus Lithographic Manufacturing Co., 4th and Arch St., will build an addition to its boiler plant. Estimated cost, $9400.

Penn., Yeadon—The Theodore Presser Co., 1712 Chestnut St., Philadelphia, is having plans prepared for a 70 x 70-ft. power house at its printing plant.

Tex., Dublin—The Texas Power and Light Co. will construct an electric-light and power plant. M. P. White, Pur. Agt.

Va., Covington—The Episcopal Home for Homeless Boys will construct a power plant. Estimated cost, $25,000.

Wash., Bremerton—City will consolidate with Charleston and Manette and will build a municipal electric-light plant to supply the 3 cities.